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Some Calculations of Glass Technology

By J. B. KRAK

(*Written for* THE GLASS INDUSTRY)

From the chemical analysis of a glass, if correctly interpreted, more information can be derived than from any other single investigation. In all cases of trouble, or defects of the glass, an analysis of the finished product should come first. In a great many cases the cause of trouble can at once be ascertained from the results of an analysis.

Let us suppose that a manufacturer receives an order for a piece of glassware which is not regularly made by him, and that it has to conform in every respect to a sample submitted with the order. Nothing except a chemical analysis will solve this problem, and from the results the composition of the batch must be calculated. Any other procedure amounts to guess-work. If the sample submitted contains both lime and lead, it would be a waste of money to omit the lime and make it a pure lead glass. If the sample is a lead flint glass, only an analysis will reveal how much lead has been incorporated in the batch.

The following example, taken from actual experience, shows how a thermos bottle glass batch may be calculated from the analysis of a piece of glass of the bottle. The analysis is as follows:

		Per cent
Silica	(SiO_2)	71.85
Iron Oxide	(Fe_2O_3)	0.48
Alumina	(Al_2O_3)	0.94
Calcium Oxide	(CaO)	5.42
Magnesium Oxide	(MgO)	4.09
Sodium Oxide	(Na_2O)	17.27
Phosphoric Acid	(P_2O_5)	0.03

The analysis shows that the ingredients of the batch are sand, limestone, magnesium carbonate and soda ash. The iron oxide, alumina and phosphoric acid are due to the presence of these substances in the raw materials. For the sake of simplifying the calculations these impurities will be neglected and it will be assumed that the raw materials are chemically pure.

The sand of the batch becomes part of the glass without loss and therefore is made the basis of all calculations. Many ingredients, however, are composed of two parts, one of which combines with the sand and becomes a component of the glass, while the other part is volatilized. In the glass which is being considered, the proportions in which the decomposition takes place are as follows:

Molecular weight of soda ash (Na_2CO_3)	106
Weight of the fixed part (Na_2O)	62
Weight of the volatile part (CO_2)	44
Molecular weight of limestone ($CaCO_3$)	100
Weight of the fixed part (CaO)	56
Weight of the volatile part (CO_2)	44
Molecular weight of magnesium carbonate ($MgCO_3$)	84.36
Weight of the fixed part (MgO)	40.36
Weight of the volatile part (CO_2)	44.00

The amount of soda ash which yields 17.27 parts of sodium oxide is $\frac{106}{62} \times 17.27 = 29.52$ parts; 5.42 parts of calcium oxide are derived from $\frac{100}{56} \times 5.42 = 9.67$ parts of limestone and 4.09 parts of magnesium oxide are derived from $\frac{84.36}{40.36} \times 4.09 = 8.55$ parts of magnesium carbonate.

The composition of the batch from which this glass is made therefore is as follows:

On a basis of 100 pounds of sand—

Sand	71.85 parts	100	pounds
Soda Ash	29.52 parts	41.11	pounds
Limestone	9.67 parts	13.46	pounds
Magnesium Carbonate	8.55 parts	11.90	pounds

Allowing two per cent loss for volatilization of soda ash the composition of the batch becomes:

Sand	100	pounds
Soda ash	42	pounds
Limestone	13½	pounds
Magnesium carbonate	12	pounds

A glass made from a batch of this composition will for all practical purposes be identical with the sample, provided that the construction of the oven, the quality of the fuel and the

general conditions are such that a batch of this kind can be melted satisfactorily. A good batch for one furnace and a certain set of conditions may prove unsatisfactory when used in a furnace of another type and fired with a different fuel. A certain amount of experience and knowledge of a number of facts are indispensable to draw definite conclusions from a glass analysis.

To calculate the composition of a glass from the batch, it is necessary to know the analysis of the raw materials. The following example may serve to show how the composition of a window glass can be calculated from the batch figures.

Batch

Sand	100	pounds
Soda ash	26	pounds
Salt cake	6	pounds
Limestone	34	pounds
Coal	0.5	pounds
Batch	166.5	pounds

Analysis of Sand	Per Cent	Analysis of Limestone	Per Cent
Silica	99.58	Silica	0.34
Iron oxide	0.11	Iron oxide	0.15
Alumina	0.21	Alumina	0.14
Calcium oxide	0.04	Calcium carbonate	98.67
Magnesium oxide	0.04	Magnesium carbonate	0.83
Moisture	0.01	Moisture	0.03
Ignition loss	0.01	Organic matter	trace

Analysis of Soda Ash		Analysis of Salt Cake	
Sodium Carbonate	99.00	Sodium Sulphate	95.67

Silica:

	Pounds
In the sand $100 \times .9958 =$	99.58
In the limestone $34 \times .0034 =$	0.12
Total silica	99.70

Iron Oxide:

	Pounds
In the sand $100 \times .0011 =$	0.11
In the limestone $34 \times .0015 =$	0.05
Total iron oxide	0.16

Alumina:

	Pounds
In the sand $100 \times .0021 =$	0.21
In the limestone $34 \times .0014 =$	0.05
Total alumina	0.26

Calcium Oxide:

	Pounds
In the sand $100 \times .0004 =$	04
In the limestone $34 \times .9867 \times \frac{50}{100} =$	18.80
Total calcium oxide	18.84

Magnesium Oxide:

	Pounds
In the sand $100 \times .0004 =$	.04
In the limestone $34 \times .0083 \times \frac{40.36}{84.35} =$	.01
Total magnesium oxide	.05

Sodium Oxide:

	Pounds
In the soda ash $26 \times .99 \times \frac{62}{106} =$	15.06
In the salt cake $6 \times .9567 \times \frac{62}{142.16} =$	2.50
Total sodium oxide	17.56

17.56 pounds — 2% (volatilization loss) = 17.21 pounds

The composition of the glass, therefore, is as follows:

	Pounds	On a Percentage Basis	
Silica	99.70	Silica	73.19
Iron Oxide	0.16	Iron Oxide	0.13
Alumina	0.26	Alumina	0.19
Calcium Oxide	18.84	Calcium Oxide	13.83
Sodium Oxide	17.21	Sodium Oxide	12.63
Magnesium Oxide	0.05	Magnesium Oxide	0.04
Glass	136.22	Glass	100.00

Yield $136.22 \times \frac{100}{166.5} = 81.75\%$

DIRECTIONS FOR THE USE OF THE TABLE OF FACTORS

To calculate the composition of the glass from the batch, multiply the weight of each ingredient with the corresponding factor. The result will give the amount of the compound in the glass.

To calculate the composition of the batch from the glass analysis, multiply the percentage reported, with the corresponding factor. The result will give the weight of the material used in the batch.

Table of Factors

For the calculation of the glass from the batch composition.

BATCH	FORMULA	FACTOR	GLASS
Boric Acid	H_3BO_3	.564	B_2O_3
Borax	$Na_2B_4O_7 10H_2O$	.366	B_2O_3
Borax	$Na_2B_4O_7 10H_2O$	.163	Na_2O
Barium Carbonate	$BaCO_3$	.777	BaO
Barium Sulphate	$BaSO_4$	.657	BaO
Calcium Carbonate	$CaCO_3$	.560	CaO
Potassium Carbonate	K_2CO_3	.682	K_2O
Potassium Nitrate	KNO_3	.466	K_2O
Potassium Sulphate	K_2SO_4	.541	K_2O
Magnesium Carbonate	$MgCO_3$	.478	MgO
Sodium Carbonate	Na_2CO_3	.585	Na_2O
Sodium Nitrate	$NaNO_3$	.365	Na_2O
Sodium Sulphate	Na_2SO_4	.437	Na_2O
Litharge	PbO	1	PbO
Red Lead	Pb_3O_4	.977	PbO
Zinc Oxide	ZnO	1	ZnO

For the calculation of the batch from the glass analysis.

GLASS	FACTOR	FORMULA	BATCH
B_2O_3	1.77	H_3BO_3	Boric Acid
B_2O_3	2.73	$Na_2B_4O_7 10H_2O$	Borax
Na_2O	6.11	$Na_2B_4O_7 10H_2O$	Borax
BaO	1.29	$BaCO_3$	Barium Carbonate
BaO	1.52	$BaSO_4$	Barium Sulphate
CaO	1.78	$CaCO_3$	Calcium Carbonate
K_2O	1.47	K_2CO_3	Potassium Carbonate
K_2O	2.15	KNO_3	Potassium Nitrate
K_2O	1.85	K_2SO_4	Potassium Sulphate
MgO	2.09	$MgCO_3$	Magnesium Carbonate
Na_2O	1.71	Na_2CO_3	Sodium Carbonate
Na_2O	2.74	$NaNO_3$	Sodium Nitrate
Na_2O	2.29	Na_2SO_4	Sodium Sulphate
PbO	1	PbO	Litharge
PbO	1.02	Pb_3O_4	Red Lead
ZnO	1	ZnO	Zinc Oxide

Standardization in the French Glass Industry*

(*Translated for* THE GLASS INDUSTRY)

The French Government has established a permanent committee on standardization. This committee was created during the war and its membership has increased since the armistice. At the present time it has already standardized numerous manufactured products. We reproduce herewith the decisions which have been taken with regard to the glass industry.

STANDARDIZATION OF WINDOW GLASS

Window glass shall have the following properties:

WEIGHT. The minimum weight per square meter (10.76 sq. feet) shall be for single strength: 4 kilograms (8.82 lbs.); for half double strength: 6 kilograms (13.23 lbs.); for double strength: 8 kilograms (17.64 lbs.).

The weight per square meter (10.76 sq. feet) shall be estimated by dividing the net weight of the glass by the total surface.

THICKNESS. The above mentioned weights correspond to the following approximate thickness: Single strength: 1.6 millimeters (1/16 inch); half double strength: 2.4 millimeters (3/32 inch); double strength: 3.2 millimeters (⅛ inch).

The thickness must be as uniform as possible. No glass shall show sudden variations of thickness and the difference between the maximum and minimum thickness shall not exceed: for single strength .7 millimeter (.028 inch); for half double strength: .85 millimeter (.033 inch); for double strength: 1 millimeter (.039 inch).

TRIPLE STRENGTH GLASS. It is customary to call glass triple strength if it has a thickness of over 3.2 millimeter (⅛ inch). The glass shall be distinguished as follows: Triple 4 millimeter (5/32 inch), minimum weight 10 kilograms (22 lbs). Triple 4.5 millimeter (11/64 inch), minimum weight 11.25 kilograms (24.8 lbs.).

The difference between the maximum and minimum thickness of the same sheet shall not exceed 1 millimeter (.039 inch).

FLATNESS. Window glass shall be practically flat. Slightly curved sheets are permissible, provided the curvature is regular.

TRANSPARENCY, COLOR. The sheets of glass shall be transparent. The color shall be uniform and slight.

GRADING. Window glass shall be classified by the manufacturers in four grades.

First Grade. Shall be entirely free from any defects whatever.

Second Grade. Shall show only very slight defects, which shall be insignificant and which shall not occur in groups.

Third Grade. Small waves, seeds and stones shall be tolerated if not numerous, and if invisible at a distance of 5 meters (5.45 yards).

Fourth Grade. Glass which shows defects, such as large waves, stones, folds and the above mentioned defects to a larger degree.

DIMENSIONS. Glass must be cut with straight edges and at right angles. The dimensions must be as indicated, with an allowance of 10 millimeter (0.39 inches) over size but without any allowance for smaller size.

The commercial sizes shall be as follows (centimeters):

132 × 30 (52 × 11 45/64 inches)	126 × 33 (49 39/64 × 12 29/32)
120 × 36 (47¼ × 14 11/64)	114 × 39 (44⅞ × 15 23/64)
108 × 42 (42 33/64 × 16 17/32)	102 × 45 (40 5/32 × 17 23/32)
96 × 48 (37 51/64 × 18 57/64)	90 × 51 (35 7/16 × 20 5/64)
87 × 54 (34¼ × 21¼)	81 × 57 (31 57/64 × 22 7/16)
75 × 60 (29 33/64 × 23⅝)	72 × 63 (28 11/32 × 24 13/16)
69 × 66 (27 5/32 × 25 63/64)	

CONTENTS AND ASSORTMENT IN BOXES. The boxes shall contain, in the sizes above mentioned:

60 sheets single strength,
40 sheets half double strength,
30 sheets double strength.

Orders shall, as far as possible, be made up so as to be deliverable in whole boxes of one size or in sizes assorted in the following combinations:

Five long sizes: 126 × 33; 120 × 36; 114 × 39; 108 × 42; 102 × 45.
Four long sizes: 120 × 36; 114 × 39; 108 × 42; 102 × 45.
Five large sizes: 96 × 48; 90 × 51; 87 × 54; 81 × 57; 73 × 60.

METHOD OF PACKING. Boxes shall contain only glass of the same grade and of equal thickness.

On the boxes the following marks will be branded:

The number of the grade of glass,
The name of the brand,
The thickness of the glass.

On the outside of the box shall be indicated:

The number of sheets,
The measurements.

If desired the boxes may carry a seal on two opposite sides of the box.

*Le Verre, No. 4, p. 61, April, 1921

German Patents on Glass Compositions

(*Supplementing those published in the May, 1921, issue*)

No. 193,421. Process for producing dark glass from brown coal ashes and peat ashes. Allendorff. February 19, 1908.

This is an addition to No. 182,266. The clay and the magnesium compounds are separated by a flushing process before the dark glass is made.

No. 197,663. Process for making a dark colored glass impervious to actinic rays. Sackur. June 24, 1908.

The glass is painted with a mixture of silver sulphide or silver sulphate or a mixture of both, and heated to 400-450° C.

No. 218,316. Process for darkening glass and enamel. Lesmuller. March 2, 1910.

This is done by the oxides of quadrivalent elements as silicon, tin, lead, titanium, zirconium, or thorium. These oxides are employed either singly or as mixtures, and are melted together with substances containing boric acid in such proportion that the melted boric acid is saturated with the said oxides. The melted substances are subjected to the action of steam or acid vapors while they cool, either when mixed with the glass or enamel, or else a dark borate glass can be first made and then added to the glass or enamel to be darkened.

The Thermal Expansion and Annealing Temperature of Glass

By W. B. PIETENPOL, Ph. D.*

(*Written for* THE GLASS INDUSTRY)

Of the properties of glass at high temperatures, one of chief interest to the manufacturer is the rate of thermal expansion. Its close relation to the proper annealing of optical and commercial glass has been shown by the writer during the past year, and the question is one which may well be considered by men in the glass industry.

The problems met during the productive stage are varied but dependent largely upon the purpose for which the glass is to be used. In the manufacture of optical glass to be used for prisms and lenses, the greatest care must be taken throughout every stage of the process in order that the glass may be homogeneous and also entirely free from strain. In commercial glassware slight strain is not of so serious consequence though of necessary consideration. The production of strain results from too rapid or irregular cooling through the annealing range. Consequently there may be a difference in temperature between the exterior and inner portion of the glass at temperatures, as will be shown later, where the coefficients of expansion are widely different. As a result severe strains may be set up during the cooling process which preclude the use of the glass for optical purposes. In commercial ware these strains may later cause disruption to take place when the glass is subjected to a stress or a sudden temperature change.

The annealing temperature has heretofore been determined by methods which involve the disappearance of double refraction, the region of heat absorption, and the rate of deformation of loaded rods. In view of the obvious fact that the need of annealing is to permit more uniform contraction throughout all parts of the glass during the change from the slightly plastic to the more rigid state, the rate of contraction is of primary importance in its relation to a suitable annealing temperature. A definite knowledge of the rate of thermal expansion or contraction is also necessary when glass is fused to glass of different composition or to other materials, as is the case when wires are sealed in glass. Previous work on the rate of thermal expansion of glass has been restricted to lower temperatures and has not brought out the important relation between expansion and annealing temperature. The purpose of the experimental work which was undertaken will thus be clear and first a brief description of the method may be of value.

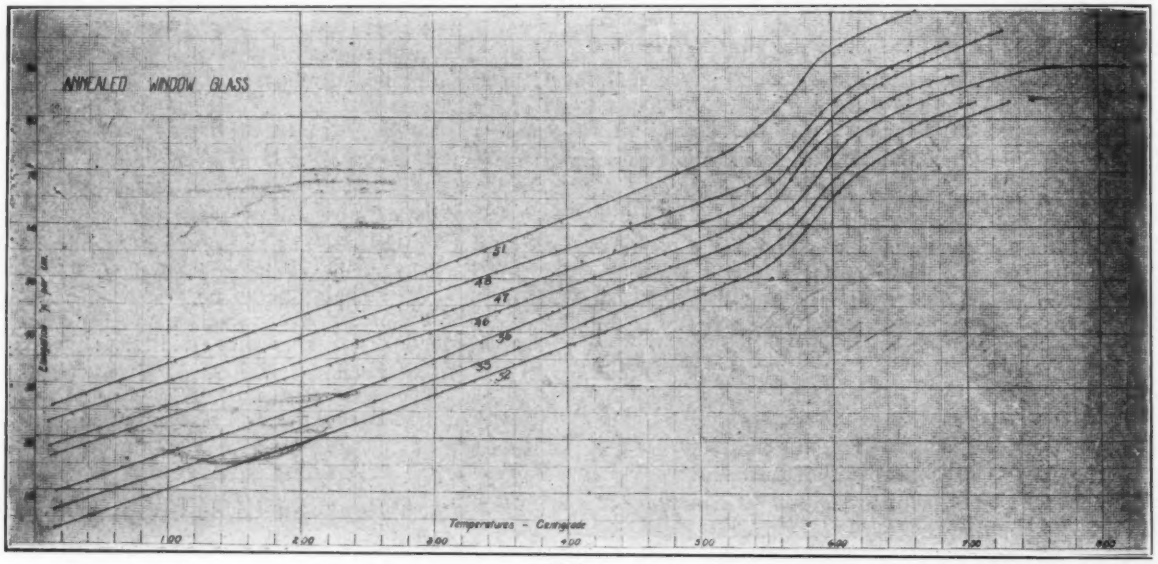

FIG. 1

An electric furnace, 100 cm. in length and 6 cm. in diameter, was constructed with small openings about 12 cm. from the ends, through which specially designed microscopes were focused upon the samples of glass. The strips of glass were about 76 cm. long and rested upon a flat piece of asbestos rigidly supported within the furnace. By the use of auxiliary heating coils in parallel with resistances the temperature was kept uniform. As measured by thermocouples, the temperatures in different parts of the furnace varied by less than one degree Centigrade during the observations. The microscopes were focused upon diamond scratches on the glass and upon small platinum particles resting upon the surface of the glass strip. By this means the temperature at which the glass began to soften could be very closely determined. The microscopes were supported upon a heavy steel frame which was kept at constant temperature during the observations. The method as adopted involves the use of relatively large strips

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of glass and the results are therefore not largely dependent upon the homogeneity of the sample tested. It is further a direct and simple method giving a high degree of accuracy. The length of the furnace was considered the maximum for convenience as the control of a uniform temperature throughout is one of considerable experimental difficulty.

The expansion of optical and other glass was measured from room temperature to about 750 degrees Centigrade. The rate of expansion of annealed glass is nearly linear until temperatures of 450 to 550 degrees Centigrade depending upon the composition of the glass. The rate of expansion then increases greatly, extending through a temperature range of 60 to 100 degrees. Beyond this range of increased expansion, at temperatures near the softening point of glass, the expansion gradually decreases and the length of the strip remains constant. At this temperature the glass loses its form and no linear expansion can be measured.

Peters and Cragoe have made measurements on the expansion of glass by an interference method and their results are given in a recent issue, No. 393, of the Scientific Papers of the Bureau of Standards. Their observations show that in every case a contraction took place just beyond the range of rapid expansion. These are, however, delusive results and are due to the method they used instead of a true contraction or a spheroiding due to surface tension as explained by them. This is conclusively shown by the method the writer used, in that microscopes were focused directly upon diamond scratches on the glass and upon small platinum particles rest-

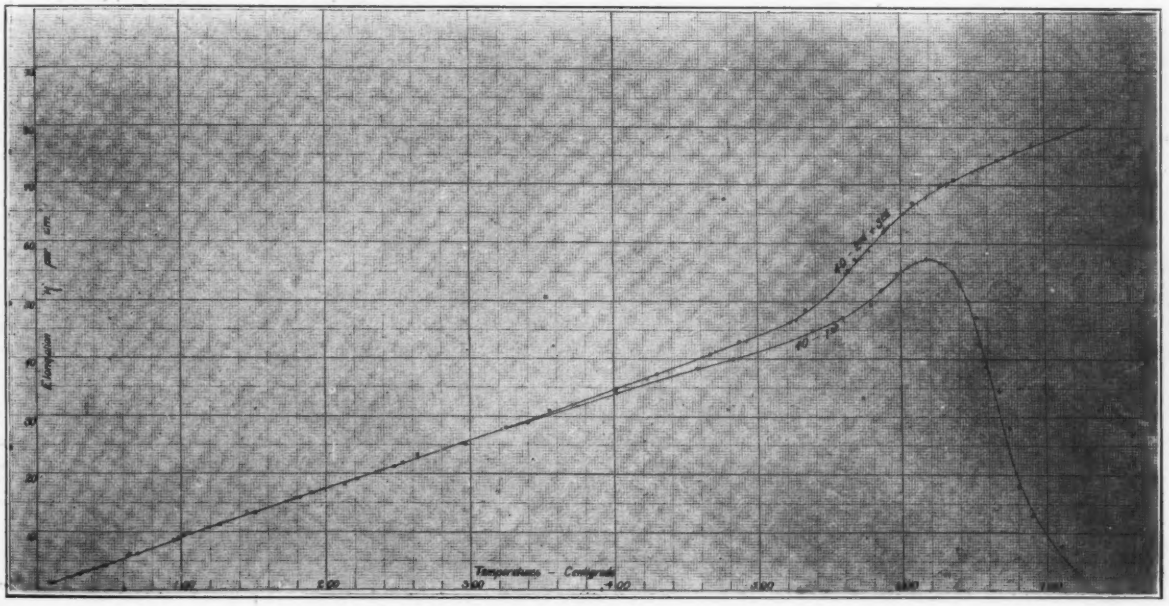

FIG. 2

the rate of expansion again decreases, being in general slightly greater than at low temperatures. These results are shown graphically in Fig. 1, where the curves represent the thermal expansion of a number of samples of commercial window glass. The results plotted are of single and double strength and plate glass as retailed by two prominent Pittsburgh manufacturers. For the glass manufactured by the one company the coefficient of expansion through a range from room temperature to 530 degrees is 0.085×10^{-4}, and for the other 0.091 to 0.094×10^{-4}. The coefficient of linear expansion, as given, represents the fractional part of its length that the glass elongates when the temperature is raised one degree Centigrade. During the increased rate through a temperature range from about 550 to 600 degrees the coefficient for this annealed window glass varies between 0.280 and 0.320×10^{-4}.

Beyond the rapid rise in rate of expansion which, as shown by the curves, is in the neighborhood of 600 or 620 degrees, the expansion again becomes nearly linear through a temperature range of 100 degrees or more. When the softening point is reached at 760 degrees as shown by curve 56, Fig. 1, ing upon the surface of the glass. In samples 46, 47, 53, and 56, Fig. 1, the first indication of any possibility of spheroidal effect, as shown by a gradual broadening of the diamond scratches, was at a temperature of 675 degrees Centigrade. Readings were taken on sample 56 to a temperature of 820 degrees. An appreciable softening in this sample took place at 760 degrees. At this temperature the small flattened pieces of platinum began to sink slightly into the surface of the glass, and further linear expansion ceased to take place as shown by the curve. It may be concluded therefore that surface tension was not the cause of the shortening of their samples at temperatures in the neighborhood of 600 degrees, and immediately after the increased expansion took place. It may be of interest to state that a method of determining the magnitude of the surface tension of glass and the temperature at which it becomes effective is at present under consideration by the writer.

At temperatures slightly above the rapid rate of expansion the glass, though not yet soft, is in a plastic state, and readily deformed when subjected to even a slight stress. Thus, as stated before, the method adopted by Peters was

responsible for the observed contraction. His apparatus, which the writer had the privilege of examining, consisted in part of a quartz plate resting upon the sample in question. The weight of this quartz plate was entirely sufficient to cause the shortening at a temperature when the glass was in the plastic state. With reference to his results, the different temperatures at which the radial and longitudinal sections of thermometer capillary gave way to the weight of the quartz plate may possibly be explained by different cross sections supporting the plate in the two cases. The greater the supporting area, the greater must be the temperature at which a given weight would cause the supporting glass to give way. Further evidence of the plastic condition of the glass at this temperature was found by the writer and the results are shown by the curves in Fig. 2. A strip of window glass similar to samples in Fig. 1 was supported in the furnace, resting upon a flat strip of heavy asbestos board which had not previously been heated. Such asbestos as found by separate experiments contracts very greatly at high temperatures. This was sufficient by friction to produce a compression in the glass which caused a rapid contraction to take place. The curve marked 40-1st represents the results of the observations under the conditions just given. The strip of glass when cooled to room temperature was found to be shorter by 0.8 of one per cent. With the same strip of glass resting upon the same piece of asbestos, two more series of observations were taken and the results which are coincident are represented by curve marked 40-2nd and 3rd. In the first run the asbestos board had been thoroughly fired, and so does not again contract at high temperatures. Curve 40-2nd and 3rd is similar in form to those for annealed glass (Fig. 1) and after both runs, when cooled to room temperature, the strip returned to its original length. The slight falling below of curve 40-1st between 400 and 600 degrees is due to the relaxation of a slight strain present before annealing.

With unannealed glass the rate of expansion in general decreases from 50 to 150 degrees before the rapid expansion takes place. This is shown graphically in Fig. 3, which shows the thermal expansion curves of unannealed light barium crown, Bureau of Standards, Melt 404. The curves show the result of observations taken upon three samples of glass, Nos. 54, 57 and 58, all of the same kind, similarly drawn from the pot and in a highly unannealed condition. Curve marked 54-1st shows a decrease in the rate of expansion beginning at 420 degrees and extending to the point where the rapid expansion begins. This decreased rate extends through a temperature interval which depends upon the strain in the glass. In some instances, as in this case, the expansion through a range of 100 degrees is practically zero.

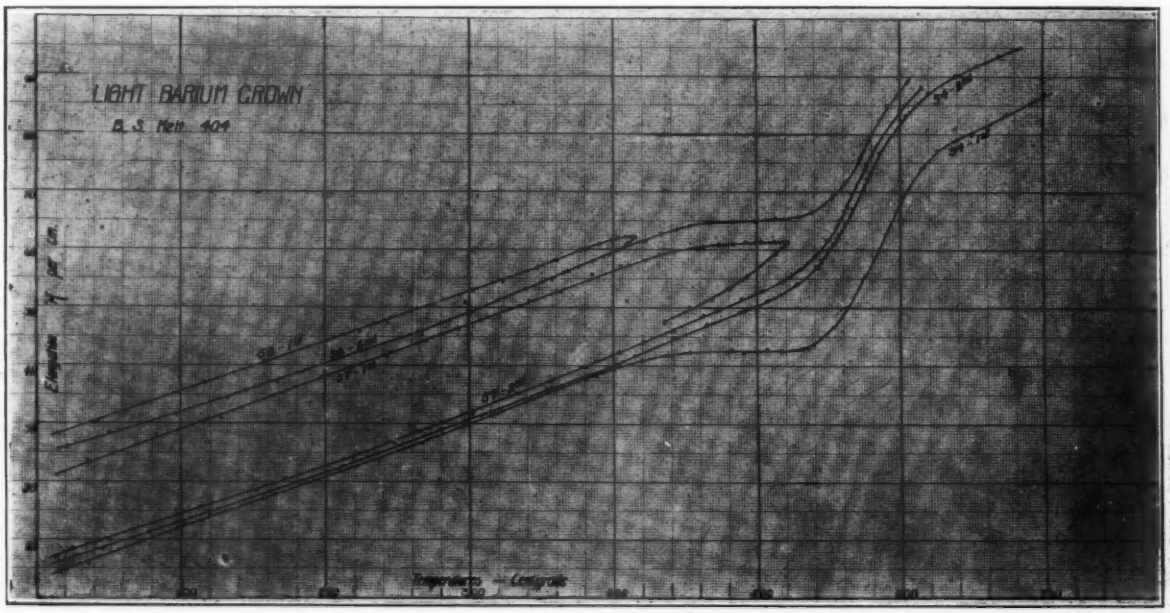

FIG. 3

Upon cooling, the strip of glass is shorter by a definite amount which is proportional to the strain relieved. If the observations are carried to a sufficiently high temperature and the glass is slowly cooled, it becomes well annealed. A second set of measurements then taken upon the same strip of glass does not show this decrease in rate of expansion but a nearly linear rate until the temperature of rapid expansion is reached. Curve 54-2nd represents the results of a second run upon the same strip of glass which had not been moved in the furnace. Since, after the first heating, the glass upon returning to room temperature was permanently shortened, curve 54-2nd is displaced upwards about 12 divisions for better comparison. The expansion curve upon second heating is similar to the ones for annealed glass as given in Fig. 1.

When an unannealed sample of the same melt of glass was heated to a point just below the temperature at which the rapid expansion begins (57-1st) the strain disappeared entirely. Observations were taken for about a hundred degrees upon cooling, and the final point determined to which the strip of glass contracted at room temperature. Without moving the strip, the glass was reheated and ob-

servations plotted (curve 57-2nd) from the point to which the glass had previously contracted. The curve is parallel throughout to curve 54-2nd, showing that the glass had been well annealed.

Curves 58-1st and 58-2nd show the results of first heating the glass to a temperature below the annealing point. Though the furnace was held at a temperature between 400 and 415 degrees for more than an hour, but a slight part of the strain in the glass was relieved. The results upon second heating, curve 58-2nd, show that the annealing temperature had not been reached. Thus a determination of the rate of thermal expansion may be used as a very exact method of finding the proper annealing temperature. For light barium crown the rate of expansion from room temperature to 400 degrees is 0.091×10^{-4} and during the rapid rate from 550 to 600 degrees it is 0.477×10^{-4}.

The rate of expansion of all glass is regular and nearly linear at ordinary temperatures and up to a temperature which is the beginning of the annealing range. This is the point where molecular rearrangement begins and strains begin to relax. The annealing range extends through a fairly large temperature interval as shown by the horizontal part of curves 54-1st and 58-2nd. At temperatures throughout the lower part of the range the annealing of glass takes place very slowly, and for ordinary purposes the most suitable annealing temperature is just below the rapid increase in the rate of expansion. This temperature for light barium crown is 525 degrees Centigrade, but varies for different glass and must be experimentally determined.

When a temperature within the annealing range is reached the glass passes out of its elastic state as evidenced by the relaxation of the strains that are present. Above the annealing temperature when the rapid expansion takes place there is possibly a rearrangement of molecular aggregates and a condition is reached where the glass is distinctly plastic. This plastic state exists through a temperature interval of 100 degrees or more, extending for certain glass from 620 to 760 degrees. In this region, the glass may be formed by blowing or drawing, the temperature determining the ease with which it may be shaped. At higher temperatures the glass becomes viscous and no longer retains its shape.

At ordinary temperatures the disruption of glass, which may take place due to a temperature change, depends upon the magnitude of the change and the suddenness with which it takes place. The break occurs due to the expansion or contraction of one portion in advance of the part of the glass adjacent to it. The thermal conductivity of glass is small, and when heat is applied an unequal expansion takes place which causes a break more readily in thick than in thin pieces of glass. Breaks due to temperature changes are more apt to result with a sudden change from hot to cold than with a corresponding and opposite change. For example, a piece of plate glass may be put from ice water into boiling water without any cracking. However, when putting the plate from boiling into ice water surface cracks appear extending an appreciable distance into the glass. Upon the application of heat the outer part of the glass expands, producing a tension in the inner portion, which under such conditions may not be of sufficient magnitude to cause disruption. With a corresponding and reverse temperature change the sudden contraction of the outer portion causes a tension along the surface where cracks are more easily formed.

When glass is cooled rapidly from the viscous to the solid state, the temperature does not remain uniform throughout and strains are introduced. Thus when the outer part cools and solidifies, the inner portion is still plastic and then passes through the region of rapid contraction. The result is that upon complete solidification there is a severe strain in the form of a tension in the inner part. This, in an extreme case, is shown in what are commonly known as Rupert's drops, made by dropping melted glass into water. The unequal cooling causes such a severe tension in the inner part that a scratch on the surface will cause the drop to burst into fragments. Furthermore a crack mechanically produced in a poorly annealed piece of plate glass will proceed first along the inner part, giving evidence of the kind of strain that is present. Likewise cracks in roughly annealed glassware advance along that part of the glass which was last in cooling.

Canadian Glass Industry in 1918

By F. H. Mason

(*Written for* The Glass Industry)

The Mining, Metallurgical and Chemical branch of the Canadian Bureau of Statistics has just issued a report of the glass industry of the Dominion in 1918, being the advance sheets of the "Chemical and Allied Products of Canada in 1918." The report is late in making its appearance, but it should be remembered that many of the departments of the Canadian Civil Service have not yet recovered from the ravages of war. A country of eight million people cannot mobilize half a million soldiers and an immense number of munition workers without its influence being felt in all departments of industry, and the Government departments have suffered with the rest.

During 1918 nine establishments were engaged in the manufacture of glass, seven of which were situated in Ontario, one in Quebec, and one in Alberta. The total capital invested in these concerns was $7,443,525, and the value of the output for the year amounted to $6,578,602. The number of men employed totalled 2,322 and $2,221,563 was paid in wages. The cost of raw materials amounted to $2,056,739 and $498,886 was expended in fuel. The principal fuel used was bituminous coal and natural gas. The products consisted of lamp and lantern chimneys, drinking glasses, bottles, jars and other pressed and blown glassware from six factories, vials and chemical ware from two, and sheet glass from one.

During the year glassware to the value of $5,430,873 was imported into Canada and ware to the value of $35,267 was exported from Canada, showing that the country produced only 54.9 per cent of its own requirements.

Consumption of Lime in Glass Works

The glass industry is the fourteenth largest consumer of lime in value among all United States industries. The annual consumption in this industry, according to figures compiled by the National Lime Association, amounted to 35,266 tons, valued at $296,234, this being 1.1% of the country's total consumption in 1920.

Pyrometric Practice in Glass Manufacture*

TEMPERATURE MEASUREMENTS IN GLASS MELTING

In the manufacture of glasses of lower melting point, such as bottle glasses, it has been customary to estimate the proper working conditions and indirectly the temperature by observing the physical and chemical properties of the mix in different parts of the furnace. Since the complete removal of bubbles, striæ, and chemical impurities in ordinary glassware is not always essential, accurate temperature control has not been considered necessary. There is no question, however, but that the application of pyrometry to the melting of ordinary glass is desirable. For the melting of optical glasses accurate control is one of the most important factors affecting the quality of the glass. For example, there is a rather narrow range of temperature above which the increased solution of the pot material results in coloring of the glass and in leakage from the pot, and below which the glass does

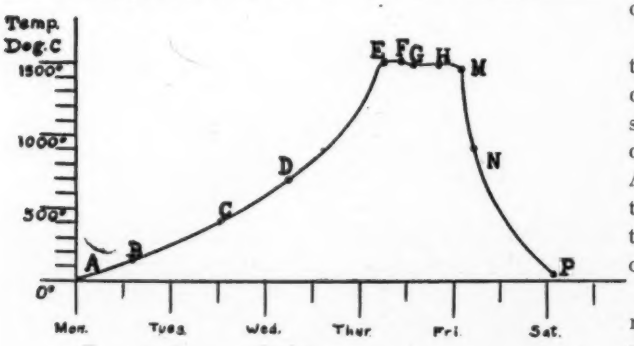

FIG. 1
HEATING AND COOLING CURVE OF A POT OF OPTICAL GLASS

not fine successfully, but becomes milky and full of bubbles. If the temperatures are not reproduced from time to time the volatilization and solution are not constant, thus resulting in changes of composition and optical properties of the various batches. The proper heat treatment must be determined for each type of glass.

Fig. 1 shows a complete heating and cooling of a particular pot of optical glass.† After the clay pot is molded and dried it is fired very slowly to prevent cracking and to a high temperature so that the sintering increases the strength. The firing takes place from *A* to *F*. From *G* to *H* the batch is introduced in several charges. From *H* to *M* the glass is thoroughly mixed by a clay stirring rod. It is then cooled and the stirring continued to *N*, during which time the bubbles and striæ are removed. At *N* the glass is so viscous that it can no longer be stirred. From *N* to *P* the glass is cooled sufficiently rapidly to break into chunks of the proper size. During the part of the curve represented by *G H M N* accurate control of the temperature is most essential.

On account of the flame in a tank furnace, a thermocouple placed at any point above the glass indicates the temperature of the hot gases surrounding it and not that of the glass. In such positions, pyrometers may often serve for general furnace control. The large differences in temperature in the molten glass and the crude process of tank-melting make it questionable whether a measure of the temperature of a particular portion of the glass affords any serviceable indication of temperature conditions. A thermocouple placed at the working end, especially in one of the arrangements used for removing glass at a definite rate, is valuable in regulating the temperature, and hence the viscosity of this portion of the glass. But the outstanding difficulty at present is the corrosion and short life of the thermocouple-protecting tubes when placed in contact with glass or even the furnace atmosphere. The destruction of the pyrometer may be avoided by sighting an optical pyrometer into a closed-end tube inserted into the glass through a diagonal hole cut in the wall just above the glass surface. The life of a tube used with an optical pyrometer is much longer than when employed as a protection to a couple.

The readings of an optical pyrometer sighted directly on the glass surface in a tank furnace are unreliable on account of the reflection of light from the flames. However, fairly satisfactory black-body conditions are obtained by sighting on the intersection of the glass surface and the opposite wall. Another method is to float a refractory block on the glass close to the wall and sight into the angle formed by the wall and the block. These methods may be checked by sighting into a closed tube.

The temperatures in pot furnaces are more uniform, and reliable measurements may be made by sighting the optical pyrometer into the pot or in some cases on the back or side walls of the furnace. Covered or hooded pots afford almost ideal black-body conditions. In general, in order to obtain the best temperature reproducibility the optical pyrometer should be used in exactly the same manner from time to time; that is, it should be sighted on the same portion of the furnace or pot.

In some glass pot and tank furnaces rare-metal couples inserted in the wall, and often not projecting entirely through into the interior, have been employed. The advantage of such an installation lies in the fact that recorders may be used and a record of the entire temperature cycle is obtained. Even though the temperature indicated is not that of the glass, sufficient control is possible, and, if necessary, the departure of the thermocouple temperature from that of the glass may be determined by the optical pyrometer. However, the continued use of rare-metal couples in a glass furnace is very costly on account of deterioration.

GENERAL PRINCIPLES OF ANNEALING

The object of annealing is to remove the strain in glass, thus minimizing the danger of breakage, and in addition, for optical glass, to make the material optically homogeneous. Annealing is accomplished by heating the glass to a uniform temperature at which it is sufficiently soft to allow the strains to relax in a short time, and then cooling uniformly to room temperature and slowly enough so that no appreciable strains are introduced. The factors which should

*Technologic Paper No. 170, Bureau of Standards.
†Keuffel, Chicago Pyrometry Symposium.

be known are the maximum allowable rate of heating, the annealing temperature, the time the glass is to be maintained at this temperature, and the temperature-time curve of cooling.

For each type of glass there exists a short temperature range, at the lower limit of which a considerable time is required for relieving stresses and at the upper limit the stresses vanish very rapidly. The upper limit is characterized by several phenomena, such as the rapid deformation of strips or rods of the glass *under load*, the rapid disappearance of the strain figures and colors revealed by polarized light, a thermal transformation marked on heating by an absorption of heat, and by a sudden increase in thermal expansion. While the deformation of the glass at the upper limit is rapid under load, the glass is by no means soft enough to produce a rounding of corners or a deformation of shape under its own weight in the time required for annealing.

Table 29 shows the temperatures of several optical glasses, made by the Bureau of Standards, at which the heat absorption and rapid change in thermal expansion take place on heating. For rapid removal of stresses temperatures 20 or 30° higher may be used, but in general it is preferable to anneal at a temperature about 20° lower, so that the cooling may be more rapid without introducing new strains.

TABLE 29.—ANNEALING TEMPERATURE OF OPTICAL GLASSES MADE BY THE BUREAU OF STANDARDS.

Glass	Temperature °C	Glass	Temperature °C
Dense flint	460	Light crown	495
Medium flint	455	Borosilicate crown	515
Light flint	485	Light barium crown	575
Barium flint	520		

The glass is held at some definite temperature within the annealing range until the strain has been sufficiently reduced and is then cooled at a rate depending upon the kind of glass, nature of the ware, dimensions, etc. Although the lower the annealing temperature the shorter the time required to cool, this gain is offset by the longer time necessary to reduce the strain at the annealing temperature. The optimum annealing temperature and rate of cooling may be determined empirically by examining for strain samples of glass cooled according to definite procedures. Without seriously increasing the strain in the finished glass the rate of cooling may be doubled for every 10° C. decrease in temperature until it reaches a value consistent with a factor of safety from breakage when it should be constant. The rate should be approximately inversely proportional to the square of the thickness of the glass. During annealing the surface of the glass must have a uniform temperature; otherwise new strains are introduced.‡

TEMPERATURE MEASUREMENTS IN ANNEALING OVENS.

The measurement of temperature in annealing ovens should serve the purpose of determining the exact temperature of the glass and the uniformity of heating. A decrease of about 10° C. in the annealing temperature requires about twice the time for the same degree of annealing. Hence comparatively greater precision and sensitiveness of temperature measurement, especially with optical glass, is required in glass annealing than in ordinary annealing processes. The temperature should be known to better than 5° C., and the sensitivity should be 1 or 2° C. A portable potentiometer or a potentiometer recorder and a sensitive thermocouple afford the best equipment. As the temperature usually remains below 650° C., a base-metal couple such as iron-constantan or preferably chromel-alumel in a calorized iron protecting tube is satisfactory.

The couples should be so located that the true temperature of the glass is being measured. Flames or cold blasts of air should not come in contact with the couple or the glass. In order to ascertain the uniformity of heating a number of couples, depending on the size of the oven or kiln, should be located at various positions. In a lehr a minimum of two couples should be installed, one near the hot end and the other near the cold end, mounted down through the arch. A recorder is especially desirable in glass annealing, since improper temperature regulation at any time during the cooling may introduce serious strains, and the record chart shows whether or not the entire process has been carried out according to specification.

‡For a detailed account of methods of annealing see Tool and Valasek, Bureau of Standards Scientific Papers No. 358.

The Bureau of Standards

The Bureau of Standards at Washington, D. C., the establishment of which was authorized by Congress over twenty years ago, is housed in the group of substantial buildings shown in the accompanying illustration. Although engaged since its inception in work of extreme importance to

AIRPLANE VIEW OF THE BUILDINGS OF THE BUREAU OF STANDARDS, WASHINGTON, D. C.

the nation's industries, it took the great world war to awaken the average glass man to a realization of the extent and value of the Bureau's accomplishments. The work of its staff in developing successful methods for the production of optical glass when importations were shut off by the war, and in investigating refractories, were of particular concern to the glass trade.

An idea, though necessarily an inadequate one, of the extent of the Bureau's activities may be had from the names of the various divisions of the Bureau. These Divisions are: Weights and Measures; Chemistry; Electrical; Engineering Physics; Metallurgy; Optical; Ceramics; Heat and Thermometry; Structural Engineering and Miscellaneous Materials.

Glass Composition for Making Bottles

By ASHER BLUM*

(*Written for* THE GLASS INDUSTRY)

It is important to many industries to have a glass composition suitable for making strong bottles, that can withstand considerable pressure. This is especially important in the mineral water and soda water bottle industries. A number of patents have been taken out directed to this point.

U. S. Patent No. 494636, dated April 4, 1893, mentions the use of a rock called phonolite which contains considerable alkali, instead of quartz sand. It stated that no carbonate of soda need be added. Green glass could be made by adding limestone and light green glass or light amber glass could be made by adding sulphate of soda and some saltpeter. This glass could withstand very strong pressures.

U. S. Patent No. 522001, dated June 26, 1894, had for its purpose to produce a strong, tough glass suitable for bottles, jars and the like. The batch was composed of clay, preferably in the form of broken brick, ordinary sand, and sodium sulphate. This produces a strong, green glass of the color known as German green. Different shades of green are produced by different proportions of the ingredients.

No. 522091, dated December 31, 1895, mentioned a composition for making amber bottle glass. The batch was composed of sand, molten furnace slag and salt cake.

*Of Mock & Blum, patent attorneys.

British Patent No. 2371, of 1855, mentioned the use of native borate of lime either alone or fritted with sodium carbonate as a substitute for borax in the manufacture of glass. The native borate of lime was purified in various ways. For a pale glass suitable for medicine bottles, the crude borate could be used.

British Patent No. 3750, of 1873, mentioned the manufacture of glass for bottles from slag obtained from smelting of iron or other ores. This molten slag was mixed with sand, cullet, soda, potash or metallic oxides. The material could be purified by adding various mineral oxides.

British Patent No. 7669, of 1875, mentions the fact that residues obtained in the manufacture of potassium bichromate, iodine and bromine can be used for making bottle glass.

British Patent No. 1557, of 1883, stated that lignite or a similar substance such as brown or wood coal, is treated with a solution of a silicate and is then distilled. The residuum could be calcined or oxidized and used in making bottles.

German Patent No. 126728, dated February 12, 1901, mentioned that the ashes of lignite or peat could be added to the frit for ordinary kinds of glass, to produce colored glass for bottles.

Compressed Air in the Glass Industry*

In the glass industry air is employed for many purposes, both at high pressures, as supplied by compressors, and at relatively low pressures, as supplied by fans and blowers.

What these uses are, and the conditions attending them may be more fully comprehended by reviewing the various operations involved in glass manufacture.

The principal ingredients of glass are silica (white sand), soda (soda ash), and lime (limestone). Large quantities of coal and clay are required for furnaces and melting pots.

In the mining of silica and coal, fans and blowers are used for ventilation purposes. Compressors are used in connection with pneumatic drills, hoists, locomotives, etc.

The quarrying of limestone is now done with pneumatic drills to provide a method for disintegrating of limestone formation.

The manufacture of soda ash on a large scale requires the saturation of ammoniated brine with carbon dioxide at a pressure of 40 pounds and the aerating, agitating and transferring of liquids by means of compressed air.

The production of fire clay pots bears a most important part in glass manufacture. After a pot is formed from clay it receives a preliminary heating in a "pot arch" where a forced draft, obtained with compressed air, is required.

Furnaces in which the glass is melted in clay crucibles are known as pot furnaces, while those in which the glass is melted in a clay tank are known as tank furnaces. Both forms of furnace are usually of the "Siemens" regenerative heating type, which has proved most satisfactory and economical.

Bottles are produced by a combination of mechanical pressing and blowing with compressed air with the aid of bottle molds. In the Owens bottle machine in which the whole operation is done mechanically, the glass flows from a melting tank into one which, revolving, carries the molten glass to the machine. The machine sucks up sufficient glass to make the bottle and at the same time forms the neck. It is then carried to a mold in which it is blown to its final shape with compressed air. Tumblers, chimneys and other cylindrical articles are blown in a mold and then revolved in the mold to eliminate joint marks.

Large objects such as vats, jars and bath tubs are made by the Sievert process. Molten glass is cast on a perforated metal table, rolled out into a sheet, and clamped to the table which is then turned over. The hot glass sags and is then blown by compressed air injected through the perforation. A mold is used to give the desired shape. Pressed glass is made by forcing a metal plunger into a heated mold, the glass filling the space between the plunger and the mold. The plunger is operated by compressed air. Compressed air is also used in glass plants for sand blasts, air lifts, acid transfer, pneumatic tools, etc. Fans and blowers are used extensively for supplying cooled, conditioned air to the work rooms where operations are accompanied by intense heat.

*Compressed Air Magazine.

The Laboratory

By J. B. KRAK

Properties, Technology and Valuation of Boron Compounds

A more general understanding of the many valuable properties which boron possesses as a constituent of glass has resulted in a large increase of its use in glass making. Boron must be considered as a substitute for silica. It is used especially in the manufacture of optical glass, laboratory ware and thermometer tubing. No element used in glass making has a smaller coefficient of expansion except magnesium, which equals boron in this respect.

Boron lowers the melting point of a glass and the condition of fluidity which it imparts to the molten metal facilitates the escape of gases, formed during the melting and fining processes. It imparts toughness to the glass and decreases the coefficient of expansion. It gives special optical properties to glass and facilitates the developments of certain colors. Its influence on the refractive power of glass is peculiar. If the silica of a glass is replaced gradually by increasing amounts of boron, it is found that the refractive index increases at first, but this property soon reaches a maximum and a further addition of boron lowers the refractive index, finally to such an extent that the borosilicate shows less refraction than the corresponding alkali silicate.

The property of boron to lower the melting point of glass has made possible the development of high silica glasses with only a small alkali content and even entirely without alkali. An example of the former kind is the well known Pyrex laboratory ware which analyzes 80.5% silica, 11.8% boric oxide, 2% alumina and 4.4% sodium oxide.

Boron is introduced in the batch as boric acid, $B_2O_3 3H_2O$ containing 54.8% boric oxide and 45.2% of water, and in the form of borax, the sodium salt of boric acid. Borax comes in trade in three forms: (1) common or prismatic borax, $Na_2B_4O_7.10H_2O$ containing 36.6% boric oxide, 16.2% sodium oxide and 47.2% water; (2) octahedral borax, containing 69.1% sodium borate and 30.9% water and, (3) water free, calcined borax containing 69.2% boric oxide and 30.8% sodium oxide. Prismatic borax is obtained by crystallization from a solution of 22° Beaume at 27° Centigrade. Octahedral borax is produced when a solution containing borax is concentrated to 30° Beaume and cooled to 56° Centigrade.

Boric acid occurs in volcanic regions, especially in Tuscany and is contained in the water of hot springs and in vapors which escape from openings in the ground. Large basins or tanks are built around these steam jets (called suffoni) and the solution is evaporated until the crude boric acid crystallizes.

In California and in Chili boric acid is made by boiling calcium borates, suspended in water, with sulphur or sulphurous acid. In Germany boric acid is made from boracite, which occurs in the Stassfurt salt deposits, by treating the mineral with muriatic or with sulphuric acid.

Nearly all borax produced in the United States is made from ulexite or "cotton ball," and Colemanite, found in Inyo, San Bernardino and Ventura counties, California. The ore is first freed from water by roasting the material in small lumps in a rotary furnace at low heat. The fine powder resulting from this treatment is boiled with a solution of sodium carbonate and bicarbonate to precipitate the lime. The solution of borax is allowed to crystallize slowly in large vats.

Borax and boric acid are obtainable in very pure condition. The determination of water is of the highest importance as its percentage, of course, affects the contents of boron. No comparison of price quotations can be made unless it is known how much water is present in the material, which may range from zero to 47%. The impurities which may occur are alumina, lime, magnesia and alkalies in the form of silicates, sulphates or carbonates. Soda ash is frequently used as an adulterant and can be recognized by the effervescence on addition of an acid. If a small quantity of borax or boric acid is fused on the lid of a platinum crucible and shows coloration, it is evidence of the presence of heavy metals.

Rapid Analysis of Borax and Boric Acid

Dissolve a 5 gram sample in dilute nitric acid, filter and determine the insoluble residue. Make the filtrate up to 250 cubic centimeters and estimate the chlorides with silver nitrate, the sulphates with barium chloride each in 100 cubic centimeter aliquots, representing 2 grams.

Treat a 1 gram sample in a platinum dish with hydrofluoric and sulphuric acids until the boron is volatilized completely. Heat until fumes of sulphur trioxide cease to be given off and weigh the sodium present in the sample as sodium sulphate. Calculate to sodium oxide by multiplying with 0.4364.

Add together the percentages of water, sodium oxide, insoluble matter, sulphates and chlorides and deduct from 100. The difference gives the percentage of boric oxide, B_2O_3.

Expansion of Glasses

The coefficient of expansion of glasses between 15° and 100° Centigrade may be calculated from their chemical composition, using the following factors, proposed by Winkelmann and Schott. To find the coefficients of cubic expansion of glass per 1° C. in millimeters $\times 10^{-7}$ multiply the percentage of each oxide by the corresponding factor given below and add the products together.

Na_2O	10.0	Li_2O	2.0
K_2O	8.5	P_2O_5	2.0
CaO	5.0	ZnO	1.8
Al_2O_3	5.0	SiO_2	0.8
BaO	3.0	MgO	0.1
PbO	3.0	B_2O_3	0.1
As_2O_5	2.0		

Lauscha Hums Again With Glassmaking Joy*

"Big Orders from America," Say the Workers, Who Put in Fourteen Hours a Day Turning Out Christmas Tree Ornaments

LAUSCHA, Saxe-Meiningen, May 5 (By Mail).—Lauscha stands, like Zion, by hills surrounded. One sniffs instinctively to catch the smell of crude petroleum, and almost expects to see oil derricks on those hills, for nothing else is lacking at first sight to indicate that one is not in some small city in Warren or Venango county, Pennsylvania.

But a glance at the streets is enough to bring the visitor back to Germany, for they are full of women, mainly old women, hurrying along under loads which, from their dimensions, would appal a packmule. Really they are not so heavy as they look—probably not more than eighty or ninety pounds at the most—but the size of them!

The fundament is the inevitable willow basket, 3½ feet high, about 2½ feet wide at the bottom, and a yard across at the top, slung from the shoulders by two straps. The basket is full. On top of it, piled up for a yard above the bearer's head, eight or more feet across, a yard from front to back, either glass tubes of all sizes up to three inches in diameter, or else paper boxes full of gaily colored glass balls, birds, tinsel, and other things with which Christmas trees are decorated. For the name of Lauscha is familiar wherever people make or deal in glass decorations, glass beads and artificial eyes.

As Busy as Bees

Today the town reminds one of an anthill or a beehive. There is a constant coming and going in the streets, a procession of persons carrying glass tubes to their homes or else bearing away the finished product to be packed for shipment. In almost every house in the town gas flames with forced draft are singing from early morning until late into the night—14, 15, even 16 hours a day, for the eight-hour dictates of the law and the labor unions are forgotten in these days.

For one thing, the industry here is almost exclusively a house industry, carried on independently by families, and the labor unions cannot reach them. For another thing, the population is normally very industrious and likes to work.

Just now, however, there is still another factor to account for the busy aspect of the town. Any child in the street tells you, with happy face:

"Grosse Auftraege aus Amerika" (big orders from America).

One realizes here, if never before, the economic interdependence of the whole civilized world. A month ago there was distress in this city of 8,000 souls, discontent, unrest—the precursors and breeders of disorder, radicalism of the reddest kind, eventually of revolution. Today nobody thinks of politics, and radical agitators talk to those who will not hear. And all this because, in faroff America, the stock of Christmas tree decorations happens to be running low somewhere.

Small occurrences often have important consequences. When some child in America, playing about his Christmas tree, breaks a frosted glass ball and a bird, it means that some child in Lauscha will have an extra slice of bread. If father stubs his toe and falls while carrying the box full of decorations up to the attic to lie there until Christmas comes again, that misstep may pay a week's rent for some family here.

Some Contracts Canceled

There is still another reason for the feverish haste with which the people are working today, and it is one which it is not pleasant to have to record. Several American orders have been suddenly canceled in the last year after the work of filling them was under way, and there is anxiety lest this happen again.

Complaints about the business morals and practices of certain American importers are by no means confined to this district. There is a feeling in German export circles that some American and English importers often show little regard for their obligations when, by taking advantage of shifting exchange rates or economic conditions, they can avoid losses or make profits by what amounts to a breach of good mercantile morals.

Lauscha's two glass works are the fundament upon which the town's economic life rests. Virtually the whole production goes into the homes, there to be worked into Christmas tree decorations and other objects made of glass. Vast piles of broken glass lie outside the factories, gathered from all the surrounding district. It is washed and goes into the great cauldrons in the furnaces with sand and soda.

The glass blower's work is arduous. The great clump of molten glass which he manipulates at the end of his long blowpipe must weigh around thirty pounds and he handles two or threescore of them every day.

Only two products of the glass works go direct to the market or the exporters. These are colored marbles and small affairs shaped like a summer squash, the whole some three inches long. One grasps the thick part firmly in the closed hand and breaks off the tip of the small end. There is a miniature explosion and one opens his hand to find it full of powdered glass, the result of the sudden release of the imprisoned particles of air.

The Family at Work

The glass tubes of all sizes, broken into lengths of about a yard, go into the homes of the makers of Christmas tree decorations. I visited one of these houses to see how those vari-shaped and vari-colored balls, birds, etc., are made. In one room were the grandmother, the mother, and the daughter, a girl of perhaps fourteen. Beside the mother was a basket full of glass balls shaped like fir cones. One by one she dipped them into some solution and handed them to the grandmother, who emptied a dishful of snow-powdered glass over them. The girl was painting little blotches of green on other balls.

In an adjoining room sat the two sons, both young men, each before a gas flame. I had often wondered how those frail glass decorations are made, but it is very simple. One takes a piece of glass tubing, holds it in the flame until it is soft, and twists it in two, closing one end. An inch or more of one end of the tube is then heated, the operator occasionally blowing into the other end until the heated end swells up to a small ball. He reaches out for the moulds—two blocks of wood joined by a handle like the handle of a pair of gardener's shears, and fitting closely together, except for a hole in the side as large as the tube that is being worked. The soft ball is placed quickly in the mould, the top half is shut down, a quick puff, and when the mould is opened one sees a melon, a cone, a bird, etc.

A Maker of Animals

In the adjoining house an old man was seated before a Bunsen burner, making animals, spinning wheels, and scores of other objects with an almost incredible cunning. He took up a piece of milky-white glass tubing about three inches long, and stuck one end of it into the flame.

"Dos wird a hund" (that's going to be a dog), he said, in his Thuringian dialect.

And in ten minutes it was a dog, a saucy terrier, with black tail and ears, a red muzzle, and reddish-brown eyes. The old man's ancestors were Huguenots, who came here some two centuries ago, and all his forefathers have made glass dogs, stags, and other things of the kind all these two hundred years.

The mayor, an intelligent young man with a decisive manner, received me with some suspicion. There have recently been several convictions for commercial espionage in central and southern

*Special correspondence of *The Globe*, New York.

Germany, and he was taking no chances. My credentials secured his confidence, and he talked freely.

WORK, NOT POLITICS

"How do the people around here think politically?" I asked.

"When there's work on hand they don't think politically," he answered. "They don't give a darn about politics if there are orders on hand so that they can work fourteen hours a day. They like to work. Two years ago we had 380 communists here. Nobody had any work at the time, and there happened to be a very clever agitator employed at one of the mills. But today I doubt greatly whether the communists could poll ten votes here. There will never be any trouble in Lauscha as long as there is work."

"Are the people monarchists?"

"They are nothing at all politically, as I have said. I don't believe there is any demand for the return of the monarchical system, and, on the other hand, there would be no objection to the establishment of a constitutional monarchy. But the old system could not be restored.

"The Christmas tree trade is booming just now, but glass eyes and beads have been dead for a year. The special glass from which the eyes are made is being exported in considerable quantities to France, England, and America, where it is being manufactured into eyes by workmen from Lauscha. But in the long run these countries will not be able to compete successfully with our industry."

The Causes of Loss in Bottles During Pasteurization and Sterilization*

By A. W. BITTING†

A summary of a number of replies received from manufacturers of soft drinks and fruit juices shows that there is a very great variation in the percentage of bottles broken during the process of pasteurization and sterilization. Some manufacturers report not more than one or two bottles per thousand, while others report losses as high as three per cent.

While there might be some slight variation in the quality of bottles, that would account for losses in particular instances, it is believed that there could not possibly be any such variation in quality as to produce these differences where manufacturers use bottles from the same source. Inquiry also developed the fact that the bottlers employed methods in their pasteurization and sterilization which varied considerably in detail.

The Research Department of the Glass Container Association obtained sets of 4, 6, 8, 16, 32 and 64-ounce bottles for the purpose of making experiments to determine the pressures generated when packing such articles as fruit juices, although the same data would apply to the packing of any material under like conditions. The total capacity of each set of bottles was obtained and then they were filled to their rated capacity and the amount of head space, or space between the level of the liquid and the cork, determined.

It was found that for the smaller-sized bottles the head space aggregated about 12 per cent of the total capacity, whereas in the 64-ounce bottles the head space was less than 5 per cent of the total capacity. This is obviously a point which needs some correction as the head space for all products which are to be either pasteurized or sterilized should be made dependent upon the expansion of the materials used.

The bottles were filled with tap water at a temperature of 60 degrees. When they were heated to a temperature of

100 degrees the water had expanded 0.7%
140 degrees the water had expanded 1.5%.
180 degrees the water had epxlained 2.6%
190 degrees the water had expanded 3 %

This means that in the case of the 4-ounce bottle the amount of head space used by the expansion of the liquids during processing may vary from 5 to 24 per cent, depending upon the temperature used, and in the 64-ounce bottle from 14 to 57 per cent. It can be readily appreciated that filling machines will not measure these capacities exactly and there will be occasional variations above and below the set amount.

The breakage was found to be much less in the small bottles than in the large ones. This can be easily accounted for by the difference in pressure generated, due to the relatively larger head space, in addition to the fact that the smaller bottles are inherently stronger than the larger ones. The pressure generated in the bottles corresponded fairly well with the reduction in head space as expansion occurred.

It was also found that water containing air, as drawn from the faucet, gave a somewhat different result from that which has previously been boiled. This latter condition would correspond to the difference in processing cold fruit juices and those which had previously been heated in a kettle.

These various factors make it somewhat difficult to calculate upon a theoretical basis the pressures which are generated in pasteurizing or sterilizing.

One very practical way of overcoming the breakage by these experiments is by preheating the bottles at a temperature of 120 degrees or even a little higher, before capping them. This can be done on a continuous belt passing through a warm water bath, and will not involve additional expense in the actual pasteurization or sterilization.

Two effects will be secured. First, a considerable part of the incorporated air or gas will be driven out; and second, the expansion of the material between 120 degrees, or the capping temperature, and the sterilizing temperature will be so much less than when packed cold. Moreover, the handling of the fairly warm bottles on the machine will be attended by less breakage than with cold bottles. By following this practice the manufacturer or packer ought to be able to reduce his breakage very considerably.

*From *Bottles*, May, 1921, published by Illinois Glass Company.
†Director of the Research Laboratory, Glass Container Association.

Tariff Revisions Affect Glass Manufacturers

The tariff revision bill now before Congress contains the following items affecting the glass industry:

Plate glass, proposed tariff, 11 cents a square foot; present tariff, 6 cents a square foot.

Bottles and blown glassware, proposed tariff, 40 per cent; present tariff, 45 per cent.

Incandescent bulbs, proposed tariff, 35 per cent, present tariff, 30 per cent.

Mirrors, proposed tariff, 30 per cent; present tariff, 30 per cent.

Eye glasses, proposed tariff, 20 cents per dozen and 15 per cent; present tariff, 35 per cent.

Watch crystals, proposed tariff, 40 per cent; present tariff, free.

Fire brick, proposed tariff, 10 per cent. ad valorem; present tariff, same. Limestone, proposed tariff, 5 cents a 100 pounds; present tariff, free. Lime, proposed tariff 10 cents 100 pounds; present tariff, 5 per cent. Gypsum, proposed tariff 25 cents per ton; present tariff, 10 per cent. Unwrought clay, proposed tariff $1.00 per ton; present tariff, 50 cents per ton. Talc, proposed tariff, ¼ cent a pound, present tariff, free. Fuel oil, proposed tariff, 25 cents a barrel; present tariff, free. Coal is left on the free list.

An important feature provides that invoices of imports must show cost prices and actual money values in the country of origin. The bill gives the President the right to impose retaliatory duties on any government which imposes higher duties than those of the United States on like products.

The Glass Industry

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NEW YORK, JULY, 1921

CONTENTS

	Page
Some Calculations of Glass Technology	159
Standardization in the French Glass Industry	161
German Patents on Glass Compositions	161
The Thermal Expansion and Annealing Temperature of Glass.	162
Canadian Glass Industry in 1918	165
Pyrometric Practice in Glass Manufacture	166
The Bureau of Standards	167
Compressed Air in the Glass Industry	168
Glass Composition for Making Bottles	168
The Laboratory:	
Properties, Technology and Valuation of Boron Compounds	169
Expansion of Glasses	169
Lauscha Hums Again with Glassmaking Joy	170
The Causes of Loss in Bottles During Pasteurization and Sterilization	171
Editorial:	
Industrial Standardization	172
New Chemical Dictionary	172
Technical Consultation Service	173
New Publications	173
Employment in British Glass Trades	173
British Glass Exports During May	173
Recent Patents	174
Glass Factory Equipment and Supplies:	
Tank and Lehr Temperature Control System	176
A New Automatic Glass Blowing Machine	178
Belgians Organize for Libbey-Owens Process	179
Glass Container Association Elects New President	180
Busy Month for Glass Men	180
News of the Trade	180
Inquiries Received	181
Foreign Trade Opportunities	181
Personal	181
Recent Deaths	181
Monthly Summary of Foreign Commerce of the United States	182
Current Prices of Glass-Making Materials	182
Stock Quotations	182

Industrial Standardization

We are fortunate to have a practical engineer at the head of the Department of Commerce. There probably never has been a time in the history of this Republic when there was greater need for a man who can sense great problems and who, at the same time, has the capacity to deal with them.

Secretary Hoover recently arranged for monthly conferences of editors of technical papers to discuss industrial standardization. The war has given great impetus to standardization, in Europe as well as in America. Under the stress of war the need of standardization was felt as a means of increasing production and decreasing waste. In the final essence, standardization aims at the production of more goods at less cost, by eliminating non-essentials.

It is no exaggeration to say that the industrial world today is face to face with a crisis greater than at any time during the war. In many industries conditions have forced costs well above selling prices. In others, sales can scarcely be made at any figure. Those who have advocated standardization to enlarge production, have felt that the same measures may now enable the industries to survive, and to gain something of permanent advantage to themselves, the consumers and the Commonwealth.

Standardization of American industry, if carried out in a big way, may become one of the important factors in the creation of a broad-gauge industrial policy, of which our country stands sorely in need, and which we must have if we desire to retain our industrial supremacy gained during the war. It will require the co-operation, in every branch of industrial pursuit, of the best brains and the biggest hearts, of men who can see beyond immediate profits, beyond their own corporations and who will dedicate themselves to their task with that same love of country which stirred the hearts of our people in 1917 and 1918.

Each industry will have its individual problems, great and small, and if standardization in the glass industry becomes a reality every branch will be called upon to formulate its particular needs. We feel sure that Secretary Hoover is going to receive the hearty support of our industry in his endeavor to revive the industrial prosperity of the country.

New Chemical Dictionary

THE CONDENSED CHEMICAL DICTIONARY.—Second Edition—Compiled and edited by the editorial staff of the Chemical Engineering Catalog. Published by the Chemical Catalog Company, Inc. 6 x 9 inches, 533 pages. Bound in library buckrum, $5.00; in flexible leather cloth with thumb index, $6.00.

This compilation has been made with the object of satisfying the demand existing for a book that would supply the outstanding facts regarding various chemicals and chemical materials ordinarily met with in commerce, in such form that it would be useful to people not educated along chemical lines. No attempt has been made to produce an exhaustive work. However, the principal properties and uses of about 7,000 chemicals, and in some cases, the method of manufacture, are given. The properties described have been restricted to those likely to be of commercial importance. The book should be of value not only to the non-technical user, but also to the chemist, for whom it will prove a time-saver.

Technical Consultation Service

THE GLASS INDUSTRY invites its readers to refer to this department any problems with which they may be confronted pertaining to raw materials, glass technology, laboratory and factory practice. While making no pretensions to the possession of unbounded knowledge or infallibility THE GLASS INDUSTRY is ready to assist its readers to the best of its ability in solving their problems. Readers who can offer better suggestions are invited to submit them.

Answers to all questions will be made by mail as promptly as possible. The source of all inquiries will be held in strict confidence.

QUESTION 10.—We have been making glass of a good color from a batch consisting of sand, salt cake, limestone and coal. Recently the color of the glass has become greenish. Please advise us what causes this color and how it can be improved?

ANSWER.—The greenish color is probably due to iron which may be present in any one of the raw materials. Salt cake sometimes is high in iron, when it is concentrated in iron pans. When lead pans are used it may be as low in iron as soda ash.

Our advice is to have the raw materials analyzed to find which one contains too much iron. An addition of from one-half to one pound of manganese dioxide to 1,000 pounds of sand may help to improve the color.

We would advise changing to a soda ash batch, using three-fourths of a pound of soda ash for each pound of salt cake. It is best to make this substitution for only four-fifths of the amount of salt cake used, and to keep on using one-fifth of the original amount. The coal used to reduce the salt cake should be diminished in the same proportion. A soda ash batch costs no more than a salt cake batch, everything considered, since it requires less heat, is less corrosive and yields a glass of a better color. We do not advise a complete substitution of salt cake by soda ash. A mixture of the two, in the proportion of four parts of soda ash to about one part of salt cake gives better results.

New Publications

AN INDEX TO VOLUME 15 (1919-1920), SCIENTIFIC PAPERS, BUREAU OF STANDARDS, has been issued by the Department of Commerce. Two papers relating to glass are included in this volume, viz.: "Optical Conditions Accompanying the Striae which Appear as Imperfections in Optical Glass," by Lieut. Commander A. A. Michelson, U. S. N. R. F., and "Concerning the Annealing and Characteristics of Glass," by A. Q. Tool and J. Valasek.

HOW BUSINESS WITH FOREIGN COUNTRIES IS FINANCED. A 74-page pamphlet issued for free distribution by the Guaranty Trust Company of New York. The primary purpose of this booklet is to outline the services and facilities offered by the Guaranty Trust Company in financing foreign trade and to explain the methods and forms generally used. Facsimile reproductions of banking forms and commercial documents used in foreign trade are given and their uses explained briefly and clearly so as to give even a reader inexperienced in the foreign field a good general idea of the methods in use.

ANNUAL TABLES OF CONSTANTS AND NUMERICAL DATA—The publication of the Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological, which was interrupted during the war, has now been resumed by an international commission acting under the authority of the International Union or Pure and Applied Chemistry. Subscription blanks for Volume IV, containing all numerical data published during the years 1913 to 1916 inclusive, can be obtained from the University of Chicago Press, Chicago, Ill.

PYROMETRIC PRACTICE.—Technologic Paper o fthe Bureau of Standards No. 170, by Paul D. Foote, C. O. Fairchild and F. R. Harrison, 326 pages. For sale by the Superintendent of Documents, Washington, D. C. Price 60 cents.

This publication, which has already been adopted as a standard text for teaching pyrometry in several universities, contains an exhastive study of high temperature measurements and should prove to be of great interest to engineers and manufacturers. The theory and practical application of the different types of pyrometers are discussed, and special chapters are devoted to recording instruments and devices used for control. The treatise, as a whole, is written in non-technical language, and no undue stress is laid on the mathematical side of the subject. The volume is a valuable addition to the literature of pyrometry.

TRADING WITH THE NEW COUNTRIES OF CENTRAL EUROPE. By Oscar P. Austin. No. 6, Foreign Commerce Series. Issued for free distribution by the National City Bank of New York. The chief purpose of this 66-page booklet is to present a condensed view of conditions in the early part of the year 1921 in the score or so of new, or newly adjusted political divisions of Europe, which have continued their existence under the difficult conditions characterizing that great area since the close of the war. Beginning at the north, they include the "Russian Federative Republic" (popularly designated Soviet Russia), Finland, Esthonia, Latvia (which now includes Livonia and Courland), Lithuania, Ukrainia, Poland, Danzig, the German Republic, the Austrian Republic, Czecho-Slovakia, Jugo-Slavia, Albania, the new Hungary, Bulgaria in its minimized form, greater Rumania, greater Greece, greater Italy and the recently established independent government of Fiume.

The exceptional facilities at the command of the National City Bank have enabled it to gather together a great many facts of interest to any one desiring to export goods to the above-mentioned countries. The information is given in much condensed form. A table is included showing the area, population, form of government, ethnic or racial stock and other information concerning each of the political units under discussion.

BIBLIOGRAPHY OF COST BOOKS, Issued by the National Association of Cost Accountants, 130 West 42nd street, New York. Price, 75 cents. This list is a compilation of about 350 books on the subject of costs in all industries.

The bibliography is limited to books, pamphlets and other material not being included. No attempt has been made to indicate the relative value of the books listed.

For convenience the bibliography has been divided into five groups:

1. Books treating the whole field of cost accounting.
2. Books on general accounting and auditing which contain some reference to cost accounting.
3. Books on industrial management which contain passages devoted to cost accounting.
4. Books dealing with cost accounting for particular trades or industries. In this section the books listed have been divided into groups corresponding to some of the leading types of industry.
5. Books dealing with some particular phase of cost accounting.

If used with due regard to its nature, this bibliography should prove a useful guide to the general literature of cost accounting. It must be used with discrimination and the value of each book listed must be considered with relation to the date of its publication and the general nature of its subject matter. The books published abroad and those published some years ago may not be of as great practical value as some volumes recently published, but they frequently present interesting material for historic or comparative purposes.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Copies of the Patent Specifications mentioned below may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c. each.

Flattening-Oven Furnace. U. S. 1,378,657. May 17, 1921. Henry F. Clark, of Pittsburgh, Pennsylvania, assignor to Window Glass Machine Company, of Pittsburgh, Pennsylvania, a corporation of New Jersey.

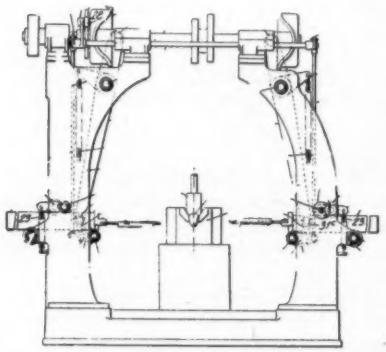
This invention relates to improvements in flattening-oven furnaces, and more particularly to gas-fired furnaces of this character. The invention is designed to provide means whereby a more perfect combustion may be obtained and the efficiency of the furnace greatly increased, and also provides means whereby the furnace, although regularly adapted to operate with producer gas, may, without interruption, be made to operate on natural or other gas, or upon fuel oil.

The producer gas is discharged into the mixing and primary combustion chamber through a nozzle, the latter having an injector action whereby air is drawn into the chamber through the opening. The result is that a proper amount of air is supplied and becomes thoroughly mixed with the gas in passing through the mixing and primary combustion chamber.

If, for any reason, the supply of producer gas should vary at any time, gas may be turned on at the burner pipes and the latter used for the continued operation of the furnace, thereby avoiding interruptions or shut-downs until such time as the supply of producer gas again becomes available.

Glass Severing. U. S. 1,379,594. May 24, 1921. Karl E. Peiler, of West Hartford, Conn., assignor to Hartford-Fairmont Company, of Canajoharie, N. Y., a corporation of New York.

This invention relates to mechanism for severing molten glass issuing from a melting tank or other container, either as a steadily flowing stream or in intermittent drops, to separate the glass in charges or gathers of definite size or quantity, to be formed into articles of glassware, or otherwise treated.



The objects of the present invention are to provide a simple, light, easily operated and efficient mechanism for this purpose, including improved devices for adjusting the cutting edges of the blades accurately into cutting contact, and guiding and holding them firmly but resiliently in contact during their cutting action.

According to this invention, the shear operating and supporting mechanism is constructed and arranged so that the cutter or cutters will be tilted or swung away from the supply outlet while they are severing the stream or the drop or gather issuing from the outlet, and by minimizing the weight of the parts to be moved and the space required by them.

In addition to this tilting movement of the blades, means are provided for adjusting the blades by a rocking movement on an axis substantially at right angles to the axis of their tilting movement, by which means the blades may accurately be adjusted so as to maintain the cutting edges in proper cutting contact.

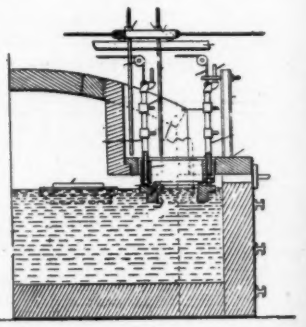
Glass-Conveying Apparatus. U. S. 1,379,593. May 24, 1921. Karl E. Peiler, of Hartford, Connecticut, assignor to Hartford-Fairmont Company, of Canajoharie, New York, a corporation of New York.

This invention comprises improvements in apparatus for feeding or conveying molten glass, as for example from a melting tank or furnace to a machine for pressing, blowing, or otherwise shaping the molten glass into glassware.

In the installation the glass is assumed to be delivered from the outlet of the throat or forehearth of any melting tank or furnace. When fed in separate gathers, as intended in this instance, the suspended gathers of glass may be severed by any suitable shear mechanism. The glass falls upon the conduit and, sliding along the conduit, is delivered into a receptacle or shaping mold, which is mounted upon a rotating table driven by or through the gear. The inclined conduit structure extends from beneath the outlet in a generally horizontal direction toward the mold, and is mounted for lateral movement at or near its ends. The lower end of the conduit is thus swung on the axis to carry it in suitable delivering alinement to the traveling mold, while delivering a charge or gather of glass thereto, swinging back and forth in similar relation to successive molds revolving with the table. The upper end of the conduit is swung aside on the axis whenever it may be desired to stop the glass shaping machine, or discontinue feeding the glass thereto, the glass so long as it continues to be discharged from the outlet being thus allowed to fall past the side of the conduit into a cullet pit or car, or other suitable receptacle, either directly, or upon another chute, conveyor, or conduit, for conveying the glass to a cullet receptacle.

Glass-Tank. U. S. 1,375,941. April 26, 1921. Arthur E. Spinasse, of Mount Vernon, Ohio.

This invention relates to an improvement in glass-tank furnaces which may be used in connection with drawing apparatus. In the construction of the glass furnace, the inventor aims to provide one or a number of drawing openings or stations suitable for drawing glass cylinders or sheets, so as to effect the drawing from a mass of glass separated as little as may be from the main body of molten glass within the tank.



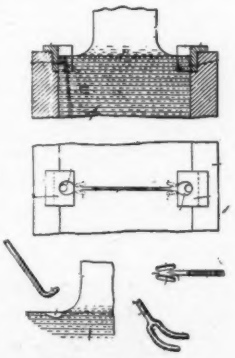
By dispensing with drawing dog houses, the glass of the drawing pool is brought very close to the main body of glass. This renders the distance through which it is necessary to float the drawing ring from a position for reducing in the tank chamber to a drawing position, very short, so that the glass is disturbed very little by such floating, thus maintaining good quality of glass and effecting a saving of time; it is also possible, when desirable, to bring the furnace hood low, near the drawing station, so that it is near the glass, whereby the heated gases are reverberated upon the mass of molten glass and into the drawing station when idle, and when covered by a suitable lid.

The general construction affords also easy means to re-

place the blocks or walls of the furnace with little delay and great facility.

The drawing dog houses in glass furnace construction are always a source of trouble, and their use the cause of much vexatious loss of time and product. By establishing within the outer contour of the furnace wall drawing stations without making use of structure from which to draw, exterior to the said contour, these objections are overcome.

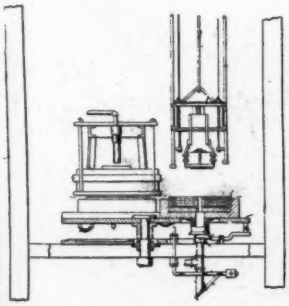
Process of Drawing Sheet-Glass. U. S. 1,376,975. May 3, 1921. Harry G. Slingluff, of Mount Vernon, Ohio, assignor to Pittsburgh Plate Glass Company.



The invention relates to the drawing of glass in the form of sheets and has to do primarily with a procedure whereby the edges of the sheet in process of generation are maintained in position and prevented from working inward and narrowing the sheet as the drawing progresses. The invention has for its principal object the provision of a simple means of procedure which may be carried out by hand manipulation or by an automatic device whereby the position of the edges of the sheet being drawn are maintained in their proper position throughout the draw and their thickness regulated, thus securing a sheet of continuously uniform width.

Glass-Drawing Apparatus. U. S. 1,375,818. April 26, 1921. John J. Bloxsom and Elmer E. Myers, of Brookville, Pennsylvania.

This invention relates to apparatus for drawing glass cylinders in which the air for blowing the cylinder is supplied at the point of draw, and has particularly to do with apparatus in which a carrier is provided with a molten glass container and is movable to cause the container to be brought to and from drawing position.



The object of the invention is to improve the air supplying apparatus to the end that adequate conduit connections may be automatically made and broken at the point of draw, and to the further end that the air supply conduit may be automatically opened to periodically free it of accumulations of broken glass or other foreign matter.

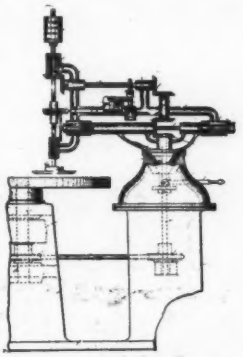
As shown in the accompanying illustration, the carrier for the molten glass containers is a turn table, and the containers arranged upon the top of the table are in the form of pots, into which molten glass is ladled prior to a draw. After a cylinder has been drawn from a pot of glass at the drawing station, the table is turned so that the pot previously at the drawing station is moved to a pot-heating station, at which the glass remaining in the pot is melted and subsequently drained from the pot. The drawing of the glass may be effected by a bait secured to a frame vertically movable upon guides by means of a hoisting cable. At the pot-heating station, or stations, the pots are heated by gas or other fluid fuel burners, a hood being provided to confine the heat.

For blowing a cylinder at the drawing station, air is supplied through a conduit, which is in fixed position at the drawing station, and a conduit which extends centrally through each pot and the portion of the table below it.

Edge-Beveling Machine. U. S. 1,368,263. Feb. 15, 1921. Albert F. Johnson, of Toledo, Ohio, assignor of one-half to Edmund Brown, of Perrysburg, Ohio.

This invention relates to a machine for beveling the edges of glass plates of circular, elliptical or other curved form.

The illustration is a side elevation of a machine embodying the invention, with parts broken away and with the work-carrying spindle in vertical position.



The spindle is intended to have free rotary and axial movements through its bearings and is provided at its lower end with a work-holding means, which, in the present instance, is in the form of a suction cup for holding a work-plate thereto.

The frame is tilted to present the edge of the work-plate at such an angle to a subjacent grinding wheel or medium as to form the desired bevel, and the frame is clamped and held in this position by a tightening of the split bearings on the carrying arms of the frame. The upper end of the spindle is extended above the sleeve and is provided with weights to exert a desired downward pressure on the spindle. The downward pressure of the spindle is opposed in the major part of a templet, which bears upward against a flanged collar on the spindle and acts on said collar to impart predetermined longitudinal movements to the spindle dependent on the shape of the templet.

The adjusting collar is automatically turned upward on the spindle at a slow predetermined speed to permit a downward feeding of the spindle and work at a speed suitable to compensate for the grinding away of the edge of the work-plate during the beveling action. It is therefore evident that the work-plate does not bear on the grinding member at the full weight or pressure of the spindle but at only a predetermined portion of such weight or pressure, as the major portion thereof is borne by the templet, and that the turning of the adjusting collar on a threaded portion of the spindle permits a slight downward feeding of the spindle to compensate for the grinding action so that the pressure of the work-plate on the grinding medium is approximately uniform during the entire beveling operation.

Device for Obtaining Quantities of Molten Glass. U. S. 1,378,460. May 17, 1921. Ernest Hopkinson, New York, N. Y.

This invention consists of a molten glass container, a movable receptacle supplied by the container and a plurality of compartments underneath the receptacle for receiving molten glass flowing therefrom. The compartments are movable about a common axis and the bottoms can be automatically opened and closed in succession.

A New Anti-Sticking Paste

The Sharp-Schurtz Company, Lancaster, O., recently put on the market, after many tests, a new material, "Double-S Mould-aid," developed to prevent glass from sticking to the molds and cause it to drop freely and quickly. Since bringing out this new trouble eradicator a number of other uses have been found for it, such as swabbing the blanks, overcoming the tendency of heated molds to stick when opening, and on bottom plates to stop heel taps. The company's announcement in a recent issue of their house publication "Double-S Fax," states that "Mould-aid" does not have to be applied to the molds oftener than two or three times an hour and that it will not mark the first bottle after swabbing as does oil, and the latter must be applied ten to twelve times an hour.

Glass Factory Equipment and Supplies

THE GLASS INDUSTRY will be glad to publish descriptions of new and useful devices, machinery and supplies of interest to the glass manufacturing trade. Most of the information printed in this department comes direct from the manufacturers of the products described.

Tank and Lehr Temperature Control System

The Pennsylvania Wire Glass Company of Philadelphia, Pa., whose plant is located at Dunbar, in the Pittsburgh district, is making wire glass, both flat and corrugated, and both colored and clear. This glass promises to have a wide field for skylight and roofing purposes, and for walls, siding and partitions as well. One of its particular features is its ability to withstand temperature variations and heavy loads. A single 60-inch sheet of corrugated material, made by the company, has been tested to a weight of 700 pounds without breaking, and uniform loads of 70 pounds per square feet have been maintained, without breakage, on sheets even longer than 60 inches in length.

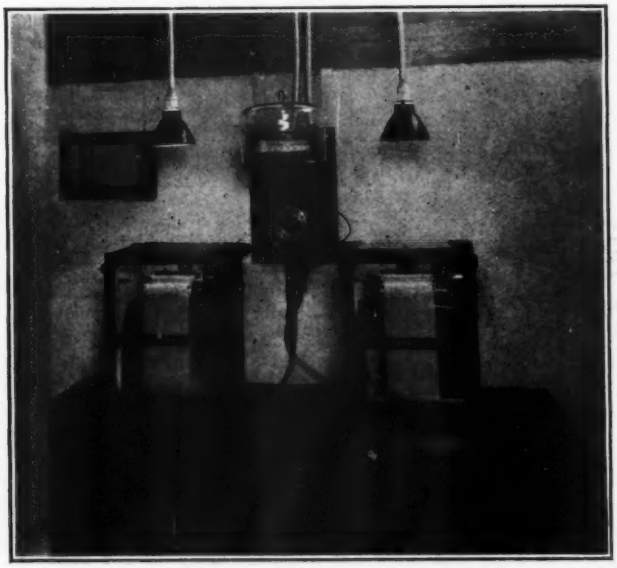


FIG. A.
Showing central station double range Mono-pivot indicator, dustproof switch and two Wilson-Maeulen Tapalogs, one recording six temperature points in lehr, and the other three high temperature points in tanks. An example of a proper and neat installation at Pennsylvania Wire Glass Company.

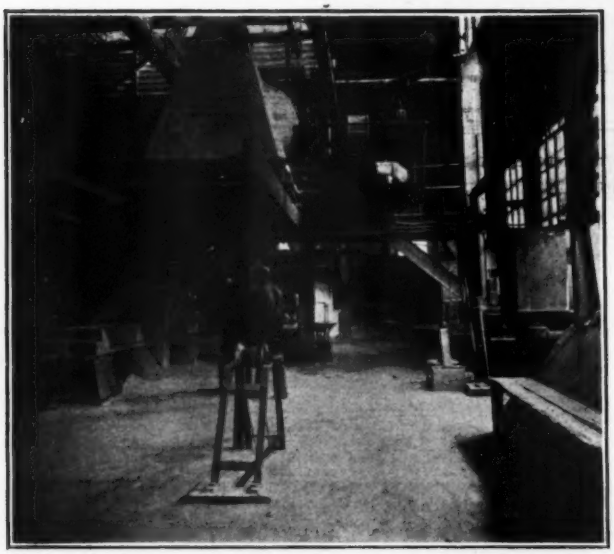


FIG. B.
Charging end of continuous tank at Pennsylvania Wire Glass Company. The indicating pyrometer is in the large case near the windows. The wiring, being neatly installed in conduit, is out of sight.

This company is one of that goodly number that has realized the need of quality in its products, and the fact that to obtain that quality, it must employ up-to-date methods and equipment. In addition to the large continuous tank, for the commercial end of the business, the company has a smaller tank for purely experimental purposes, in which it is constantly making tests, chemical and otherwise, so that all problems which present themselves from a chemical standpoint, may be solved by the laboratory force and the consulting chemist; and others arising out of mechanical conditions may be solved in the engineering department, without in any way affecting the regular run of the plant.

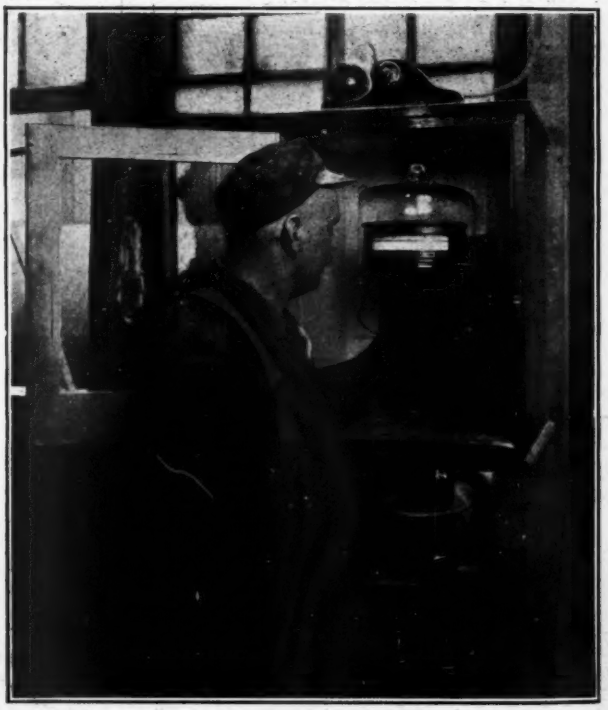


FIG. C.
Closer view of Wilson-Maeulen pyrometer indicator located near melting end of furnace. The glass dustproof dome is the standard protecter for Mono-pivot indicators and may look odd, but it is extremely practical. The large wooden box is not part of the regular equipment and is not requisite.

Three special products developed by the company as a result of constant experimenting are: "Aqueduct" glass, which by means of ribs or channels of carefully calculated design and dimensions, holds condensation by capillary attraction, and causes it to be led off in prepared channels, thus preventing drip; corrugated wire glass, which gives great strength and a splendid diffusion of light; and "Actinic" glass (No. 213) which, as shown by tests made by the Bureau of Standards at Washington, excludes over 85% of the ultra violet rays, and over 55% of the infra red rays—the two rays of light that cause "eye fatigue."

In manufacturing all of these products and in all of its opera-

tions, the company uses the best apparatus it can get, and the excellent reputation enjoyed by the material made in its plant may be ascribed to the progressive methods and the up-to-date apparatus employed, one of the most important elements of which is the excellent temperature control of the furnaces and lehr and the thorough annealing to which all of its products is subjected.

Both the tank and lehr are controlled by a pyrometer system made and installed by Wilson-Maeulen Company, Inc., New York. It is a combined indicating and recording equipment. The Tapalog records are an important factor in accomplishing the proper control of temperatures.

In Fig. A are shown two Tapalogs. The one at the left recording autographically in six different colors on one record sheet the temperatures at six points in the lehr, while the instrument at the right records in three colors the temperature at the melting end and at the refining end of the continuous tank, and at one point in the small tank. The Indicator located between and over the two Tapalogs, is a double range instrument, connected through a dust-proof rotary switch to all of the thermo-couples in the plant. The instruments shown in Fig A are located in a small room right down in the shop, and because these recorders are located so conveniently to the operators of both the tanks and the lehr, as well as the men in charge of the rolling table, they furnish not merely a history of temperatures for subsequent analysis, but constantly furnish an indication of the *trend* of the temperatures in the tanks and lehr. By referring to the Tapalog, information is to be had as to whether the temperature at any point is rising or falling, and for what length of time that has been the case. These recorders are not mere watchmen, but are tools in the hands of the furnace operators, to give them intelligent guidance.

After the recorder charts have thus served their first purpose, they are removed in 24-hour strips, and sent to the manager of the plant, who is thereby furnished with an accurate record of the temperatures maintained at all couple locations in both the tanks and lehr, and he then knows the amount of variation in temperature experienced during the 24-hour period of day and night.

Fig. B illustrates the charging end of the continuous tank, and at the right of that illustration, near the windows, will be seen a large wooden box containing the Mono-pivot high temperature indicator shown in Fig C. That instrument is connected only to the three platinum couples of the tank furnaces.

In Fig. D is given a wiring diagram, showing in principle, but not completely, the electrical connections which permit reading the tank temperatures on both indicators, and recording the tank temperatures on one Tapalog, and the reading of lehr temperatures on the indicator in Fig. A, and recording of those temperatures as well on one Tapalog.

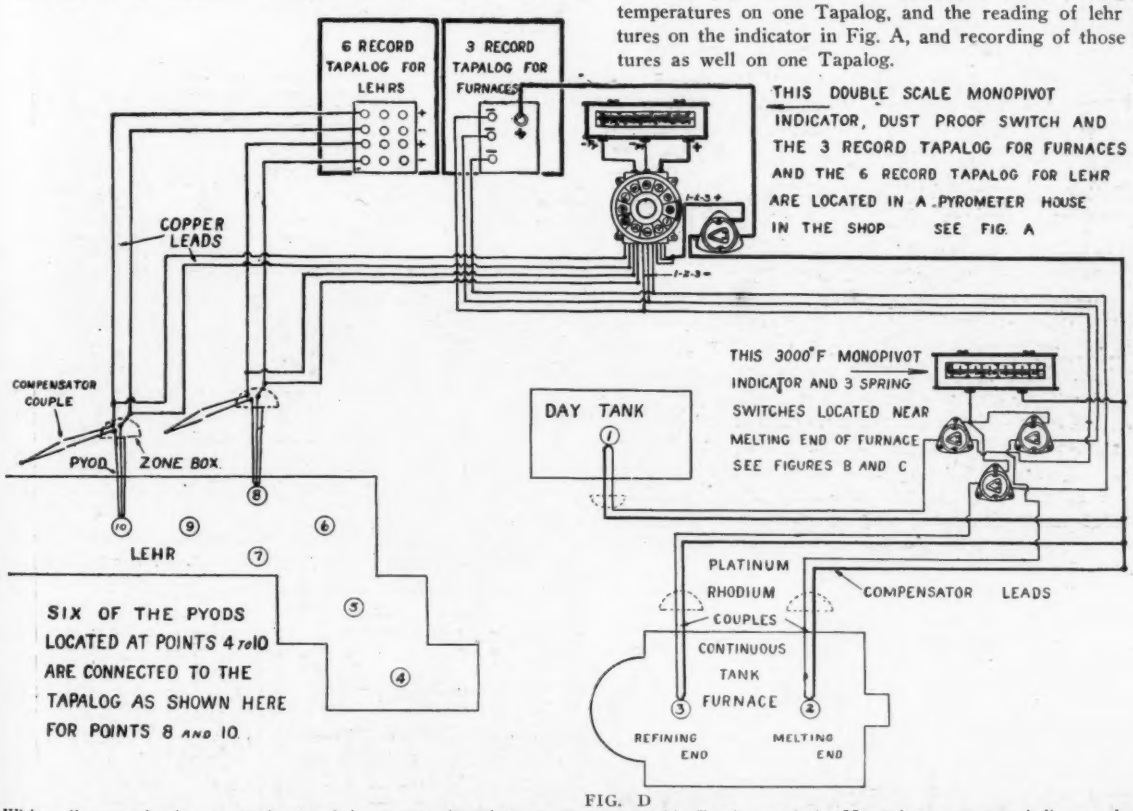

6 RECORD TAPALOG FOR LEHRS
3 RECORD TAPALOG FOR FURNACES
THIS DOUBLE SCALE MONOPIVOT INDICATOR, DUST PROOF SWITCH AND THE 3 RECORD TAPALOG FOR FURNACES AND THE 6 RECORD TAPALOG FOR LEHR ARE LOCATED IN A PYROMETER HOUSE IN THE SHOP SEE FIG. A
COPPER LEADS
COMPENSATOR COUPLE
PYOD
ZONE BOX
THIS 3000°F MONOPIVOT INDICATOR AND 3 SPRING SWITCHES LOCATED NEAR MELTING END OF FURNACE SEE FIGURES B AND C
DAY TANK
LEHR
SIX OF THE PYODS LOCATED AT POINTS 4 TO 10 ARE CONNECTED TO THE TAPALOG AS SHOWN HERE FOR POINTS 8 AND 10
PLATINUM RHODIUM COUPLES
COMPENSATOR LEADS
CONTINUOUS TANK FURNACE
REFINING END
MELTING END

FIG. D

Wiring diagram showing connections and inter-connections between the autographic Tapalogs and the Mono-pivot pyrometer indicators through dust- and fume-proof switches to platinum-rhodium couples in the tanks and base metal pyods in the lehr at Pennsylvania Wire Glass plant, Dunbar, Pa. Note that tank temperatures can be read on both indicators as well as being recorded by one Tapalog. Temperatures at six points in the lehr are all autographically recorded by one other Tapalog.

All of these indicators and recorders are made with special regard to dust-proofness. The recorders, by taking all associated temperature records on one chart in distinguishing colors, synchronize those records, so that in the lehr, for instance, the curves of the temperatures at six different points can all be observed and considered together. The two Tapalogs, taking continuously nine records, which are torn off in 24-hour periods, give about 250 autographic records per month, and yet to obtain all of these, only two charts, that is, one roll of chart for each recorder per month are inserted, and each day only two pieces of chart have to be filed for these nine records.

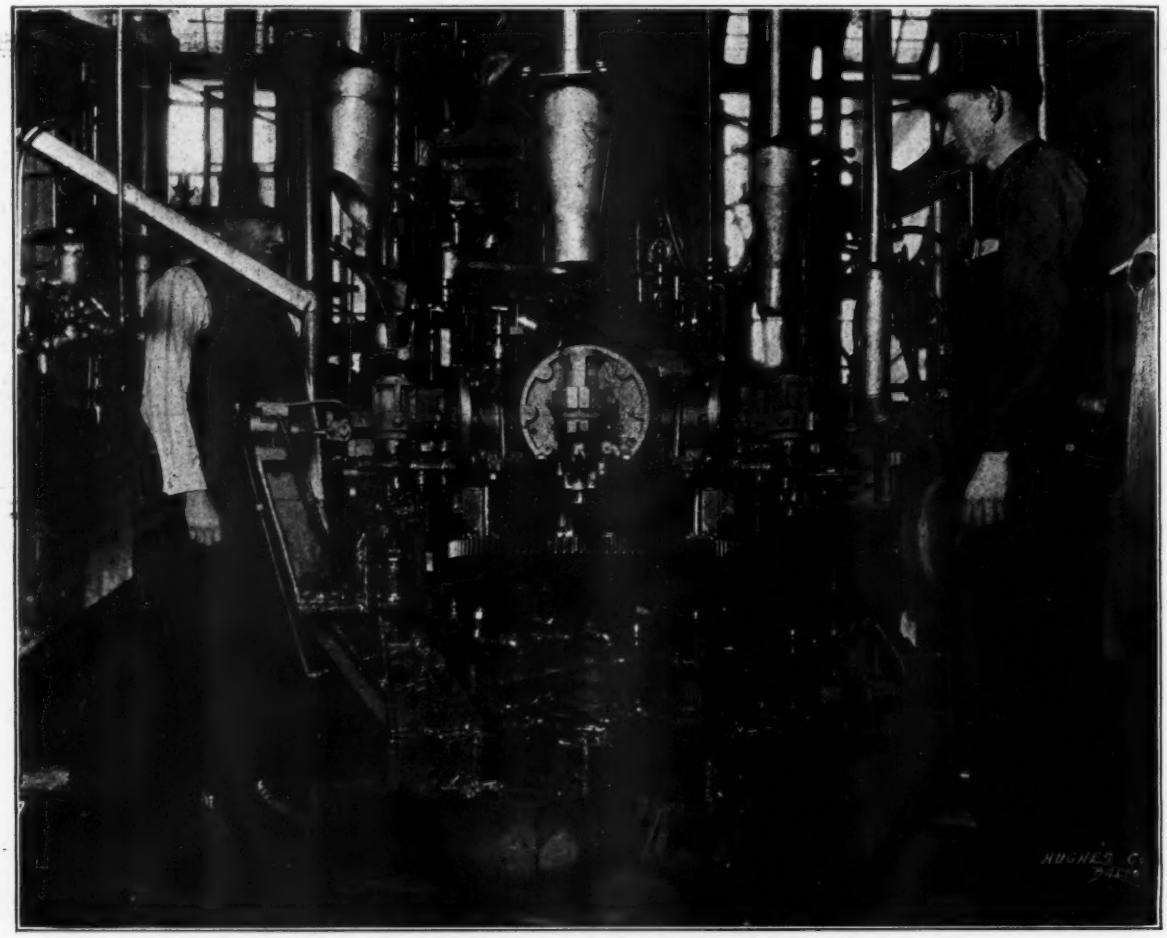
The operating force of this plant has been very efficient in using this pyrometer equipment, and the exceptional load carrying capacity of the glass product, and its actual ability to withstand radical temperature variations, speaks well for the good glass-making temperatures, and the thorough and even annealing of the sheet.

One of the interesting features of this plant is the boiler room, built entirely, walls and roof, of corrugated glass, and the soft diffused light in the room is an excellent example of what corrugated wire glass will accomplish in industrial lighting. The same material is also widely used in other parts of the plant.

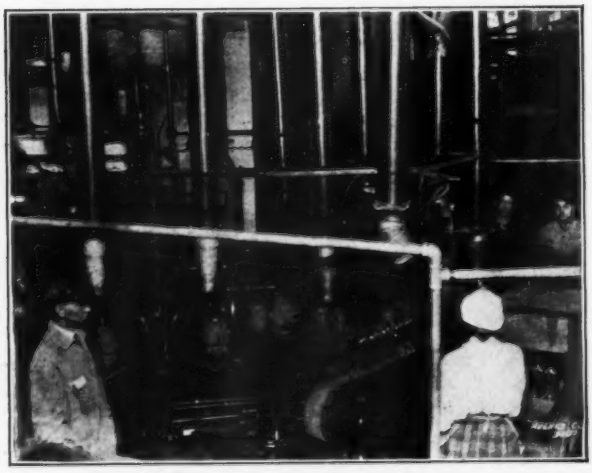
A New Automatic Glass Blowing Machine

A new automatic glass blowing machine, the latest creation of Frank O'Neill, president of The O'Neill Machine Company, Toledo, Ohio, and known as "No. 30," is about three-quarters the size of the standard "No. 25" and operates at an air pressure of 35 pounds. It is designed along lines similar to No. 25, but carries only five blanks while the No. 25 has six.

In speed the new model runs from 18 to 20 per minute and the manufacturers state that under good working conditions it will



O'NEILL NO. 30 MACHINE AT MARYLAND GLASS CORPORATION, BALTIMORE, MARYLAND
ONE OF THREE CONNECTED TO FEEDER



O'NEILL NO. 25, CONNECTED TO SINGLE FEEDER AT MARYLAND GLASS CORPORATION, BALTIMORE, MARYLAND

even do better. It can be used with any feeder and the makers point out that it has been thoroughly tested out also with hand feeding. The new machine is intended for small ware ranging from ½ ounce up to 12 ounce capacity, and 8 inches in height under the finish. Among its new features are a stationary cam to open the blank as it approaches the transfer point, which saves considerable time in transferring; a double finish blowing arrangement, which prevents bottles such as panels and thin ware from sagging. It also helps to set the glass, so that it will be in better condition to rest on the conveyor. This double blow arrangement can be disconnected so only one blow head will operate. The No. 30 machine also introduces a new type of take-off device. This take-off device lifts the bottle from the mold in a vertical, radial motion, just the same as a boy would take it out with a pair of tongs. Most take-off devices are either a horizontal slide, or have a horizontal radial motion, and as everyone knows, this causes the bottle to swing in the gripping tongs, thereby, in some cases, causing cheeks in the neck, or bending it.

The larger cut shows one of a battery of three No. 30 machines connected with a feeder and making a well known proprietary bottle. The small cut shows a standard No. 25 machine connected

to a single feeder, which, on its first twenty-five hour run, made a production of 18 per minute on 5¼ ounce bottles.

Blow or finish molds which have been used on the No. 25 machine can readily be adapted to the No. 30, and in quite a number of cases it will be possible to use the blank or parison mold.

It is interesting to trace the development of the O'Neill machines from the first type built years ago, through various intermediate stages, each bringing the model nearer to the automatic until now when, attached to a feeder, the machine is absolutely automatic. Further developments with a view to saving labor are coming, according to F. E. H. Jaeger, secretary of The O'Neill Machine Company, who states that it will only be a short time until O'Neill machines are absolutely automatic from tank to conveyor.

The Company's Toledo plant, where the machines are made, is housed in a modern day-light factory with every convenience possible for its employees. The building is fire-proof, equipped with a sprinkler system, and its employees have access to a lunch room in the building where good, wholesome food is supplied at a moderate cost.

Besides having the plant taxed to its limit by domestic orders, the foreign business of the company has become so large that last year a plant was opened at Albany Works, Trenmar Gardens, London, England, with Wilson M. O'Neill, vice-president, in charge. This puts the company in an excellent position to look after its extensive foreign trade in machines and molds. During the past year the company has shipped machines to England, Scotland, France, Switzerland, India, Canada, Mexico, Argentine Republic, Venezuela, Brazil and Japan. Some recent installations in the United States were at the Hazel-Atlas Glass plant, Washington, Pa.; the Hygeia Glass Corporation, Lancaster, N. Y.; Salem Glass Works, Salem, N. J.; Maryland Glass Corporation, Baltimore, Md.; Lynchburg Glass Works, Lynchburg, Va.; American Glass Works, Richmond, Va.; Nivison-Weiskopf Company, Reading O., and the Sheffield Glass Bottle Company, Sheffield, Pa.

OFFICERS OF THE O'NEILL MACHINE COMPANY

FRANK O'NEILL, President

F. E. H. JAEGER, Secretary

WILSON M. O'NEILL, Vice-President

Belgians Organize for Libbey-Owens Process

(*Translated for* THE GLASS INDUSTRY)

The *Monitor* has published the articles of incorporation of the "International Company for the Mechanical Manufacture of Glass"* (Compagnie Internationale pour la Fabrication Mécanique du Verre.)

The capital stock of the company amounts to 60 million francs and is divided into the following classes:

48,000 8 per cent non-cumulative preferred shares, par value 500 francs.

72,000 8 per cent non-cumulative shares of capital stock, par value 500 francs.

36,000 common shares without par value.

The 72,000 shares of capital stock are held by a number of financial and industrial corporations. The Bank of Brussels holds 10,133 shares. The Libbey-Owens Sheet Glass Company holds 7,200 shares.

The 48,000 shares of preferred stock and the 36,000 common shares are held by the Libbey-Owens Sheet Glass Company as a compensation for the use of their patents.

The Libbey-Owens Company grants the exclusive rights to install and operate in Belgium, either directly or through subsidiary companies, an unlimited number of Libbey-Owens sheet glass machines. It gives to the company the right to export to all European countries glass made by the Libbey-Owens process, also the rights to all improvements which the Libbey-Owens Company may obtain, until January 15, 1934. The company obtains the rights to export its products to all other countries of the world except Canada, Newfoundland, Prince Edward Island, the United States, Central America, Cuba, Japan, Korea, Formosa and the possessions and protectorates of the United States.

In regard to South America, the rights to export will cease as soon as the Libbey-Owens Company disposes of its rights in these countries.

The Libbey-Owens Company will give assistance and technical advice required to install the machinery and the necessary instruction to assure proper operation of the same.

The patents referred to are those which have been obtained or are applied for in Europe, based on U. S. Patents Nos. 1,160,692 and 1,248,809 and those which are obtained by transfer or any other way.

After five years, the preferred shares will be retired at 575 francs per share, by annual drawings out of the surplus. The amount to be thus retired will be decided on by the administrative council.

The first general meeting will be held on the first Wednesday in October, 1922. The Directors are Messrs. Pione Bautier, Baron Henri de Truax de Wardin, Camille Brichart and Baron Arnold de Woot de Trixhe.

La Verre, No. 5, p. 89 (May, 1921)

The Seventh National Exhibition of Chemical Industries will be held this year at the Eighth Coast Artillery Armory, Jerome avenue and Kingsbridge Road, New York, during the week beginning September 12. During the week preceding the exhibition a joint meeting of the Society of Chemical Industry and American Chemical Society will be held.

Glass Container Association Elects New President

C. J. Root, president of the Root Glass Company, Terre Haute, Ind., was unanimously elected president of the Glass Container Association at the meeting of the directors held in New York City on June 9th. Mr. Root succeeds John D. Biggers, who has served the association as its president since its organization two years ago.

Mr. Biggers has been ill with typhoid fever and was unable to attend the recent annual meeting of the Glass Container Association at Atlantic City, at which time he was re-elected for a third term. At the New York directors' meeting, Mr. Biggers explained his strong belief in a policy of rotation in office and insisted that it was for the best interests of the association that there should be rather frequent changes in the personnel of the officers and directors, so that all members would eventually have an opportunity to actively participate in formulating association policies, and would consequently take a greater personal interest in its problems and achievements.

JOHN D. BIGGERS,
Retiring President

The directors accepted Mr. Biggers' resignation with expressions of regret and unanimously concurred in Mr. Biggers' nomination of Mr. Root for the presidency. Mr. Biggers will remain upon the directorate of the Glass Container Association.

The choice of Mr. Root as president will be heartily approved by glass manufacturers everywhere. Mr. Root has been successfully engaged in the glass business for many years, and has always taken an active interest in association work. During recent years, Mr. Root has been a member of the executive committee and of the managing committee of the national association, in addition to being a director of the Glass Container Association. He has the confidence and respect of all manufacturers, both large and small. His election assures the continued success of the Glass Container Association and will assuredly perpetuate the spirit of close co-operation which has enabled the Glass Container Association and the National Bottle Manufacturers' Association to work in complete accord for the best interests of the industry.

Busy Month for Glass Men

Midsummer as usual will find the glass manufacturers and workers occupied with conventions and conferences, one of the uppermost topics for discussion being the wage scales.

The convention of American Flint Glass Workers' Union at Sandusky, O., which opened on July 5, started the ball rolling. On July 11, the Glass Bottle Blowers convene at Montreal. On Monday, July 18, at 2.30 P. M. the 45th annual meeting of the American Association of Flint and Lime Glass Manufacturers will be held at the Marlborough-Blenheim Hotel, Atlantic City. On the morning of the same day and again on Tuesday, July 19, meetings of the National Association of Manufacturers of Pressed and Blown Glassware will be held at the same place and beginning on Wednesday, July 20, the manufacturers will meet the wage committees of the American Flint Glass Workers' Union for the annual conference.

The National Bottle Manufacturers' Association is scheduled to meet at Atlantic City on July 28 and 29, the Glass Container Association meeting will also be held there on July 28, 29 and 30. Early in August the Glass Bottle Blowers' Association representatives will meet the manufacturers at Atlantic City for the discussion of wage questions.

News of the Trade

Early this month many rumors were current in the Pittsburgh district that control of the Hazel-Atlas Glass Company had passed to a large competitor.

F. J. DENK, consulting mechanical and fuel engineer, formerly located in the House Building, has taken an office in the Shannon Building, Rooms 45 and 46, 326-328 Fourth avenue, Pittsburgh, Pa.

JOHN N. ILLIG, manufacturer of cut and engraved glassware, Corning, N. Y., announces that he has taken over the factory of the O. F. Egginton Company at the corner of State and Fifth streets that city.

The firm of F. F. LARMOYEAUX & SON, Inc., was recently chartered at Clarksburg, W. Va., with a capital stock of $10,000 to deal in glass. The incorporators are: Felix Larmoyeaux, I. W. Monroe and G. H. Duthrie.

According to press reports the J. SCHOONOVER GLASS COMPANY with plants at Scranton and Wilkes-Barre, Pa., has purchased two-story brick building on Turner street, Allentown, Pa., and will establish a mirror manufacturing plant and beveling department.

THE SPRING CITY GLASS WORKS, LTD., Spring City, Pa., which has been operated as a partnership between Anthony Van Hook, Andrew Keyser, George W. Clevenger, Josiah Westcott, Charles W. Currenden and William G. Kline, has been dissolved, according to a press report.

THE POINT MIRROR COMPANY, Pittsburgh, Pa., has been organized by H. F. Vegeler to manufacture windshields and mirrors and do beveling, resilvering and ground and polished edges on plate glass. The plant of the new company is located at Penn avenue and Barbeau street.

A press report states that a new glass manufacturing concern has been organized in Japan and will be known as the TOKYO GLASS INDUSTRIAL COMPANY, LTD. The company is reported to be capitalized at 100,000 yen and will have offices at 13 Unemecho, Kyobo-shi-Ku, Tokyo.

The Cleveland office of the ROESSLER & HASSLACHER CHEMICAL COMPANY, manufacturers of chemicals, New York, is now under the management of C. D. Dittmar, formerly in charge of the Cincinnati office. The Cincinnati and Akron offices have been consolidated with the Cleveland office.

THE COMBINED MOSAIC AND STAINED GLASS CORPORATION, 33-35 West 45th street, New York, has been incorporated with a capital stock of $100,000 by M. Elson, M. A. Barrett and M.

Gries. The company has purchased the equipment and good will of the O. S. Kimberly Company and will design and execute ornamental windows in antique, stained and leaded glass.

THE ILLINOIS GLASS COMPANY, Alton, Ill., announces the opening of a new branch office at 318 Prudential Building, Buffalo, N. Y., which will be in charge of C. W. Davis. Definite plans for the new territory have not as yet been decided upon, but according to the company it will include the entire state of New York except the extreme southeast section of the state, now being handled by the New York branch.

The Southern Bottle Manufacturing Company, 402 Curry Building, Tampa, Florida, recently organized with a capital of $150,000, has awarded the contract for construction of their new plant to Oatley & Jones, Tampa. Work has already begun and it is planned to have the factory in operation by October 1. J. F. Jones is president; R. L. Rundell, vice-president and general manager; A. B. Jones, secretary-treasurer.

A new company known as GEORGE R. WEST & SONS has been organized at Jeannette, Pa., by George R. West, formerly president of the Westmoreland Specialty Company, Grapeville, Pa., and Charles H. and George L. West. The company will erect a modern glass decorating plant and will use high grade blanks for the production of glassware products. They will also make wrought iron specialties. It is expected that the plant will be ready for operation about August 1st.

THE VARIETY GLASS PRODUCTS COMPANY, Passaic, N. J., has been incorporated with an authorized capital stock of $35,000 to manufacture opal glass towel bars and pressed glass utilities. The officers of the new company are: Henry J. Fixsen, president; Henry S. Hubschmitt, vice-president; James H. Penn, secretary, and Albert Trommel, treasurer. The present offices of the company are located at 816 Main street, and they expect to erect a plant at once which, according to James H. Penn, secretary, will be ready for operation about September 1, 1921.

The *Republican News* of Mt. Vernon, Ohio, recently announced the organization of a new glass company, the leading individual of which is Rex Lamb, who was formerly interested in the Essex plant at Mt. Vernon before it was taken over by the Thatcher interests. A complete new plant for manufacturing milk bottles is to be built this summer. However it is understood that but one tank will be put in this year and the others to complete the plan will be added later. The officials say they will be making bottles about October first. The contract for the plant construction has been signed and ground is already broken. The Chapman Engineering Company, a Mt. Vernon organization, nationally known as glass plant and producer gas engineers, will have complete charge of construction.

Special Meeting of Glass Division

Secretary E. Ward Tillotson announces that a special meeting of the Glass Division will be held at Canton, Ohio, on Monday, July 25th, in connection with the summer meeting of the American Ceramic Society. The most important subject for discussion will be the report of Charles O. Grafton, chairman of the committee on the proposed trip to England next year. The report of the Committee on Standards relative to the Bureau of Standards specifications for lime used in glass making will be presented by Prof. Silverman.

Inquiries Received

Further particulars may be obtained from The Glass Industry.

No. 30. (From Chemnitz, Germany.) I am looking for glass working machinery and tools. Please send me a specimen copy of your paper containing advertisements.

No. 31—Please mail sample copy with ads of glass making equipment, blowers, furnaces, etc.

Foreign Trade Opportunities

34986—A merchant in Mexico desires to purchase chemicals and glassware. Quotations should be given f. o. b. New York or San Francisco, and c. i. f. Mexican port. Correspondence should be in Spanish. Reference.

35013—The American agents of a large Japanese house wish to receive quotations for the purchase of sirup jars. Payment to be made in New York. Reference.

35025—A merchant in India desires to purchase electrical goods and appliances, such as bulbs, shades, lamps, etc. Quotations should be given c. i. f. Calcutta. Reference.

35087—A merchant in Canada desires to purchase glass dash churns. Quotations should be given f. o. b. port of shipment. Cash to be paid. Shipment may be made all rail. Reference.

35052—A manufacturer in Italy desires to purchase machinery for the manufacture of 30,000 glass bulbs for making electric incandescent lamps per day; 30,000 glass bottles per day; and for making 2,000 square meters of window glass per day. Quotations should be given c. i. f. Italian port. Correspondence should be in Italian or French. References.

35067—A mercantile firm in Mexico desires to purchase chemical products, soda ash, lump sulphur, etc. Quotations should be given c. i. f., Mexican delivery, or Nogales, Arizona. Reference.

35093—A commercial agent from Venezuela who has been in the United States for some time is about to return to Venezuela and desires to secure an agency for the sale of medical and pharmaceutical goods, glassware, etc. References.

Personal

IRVING E. ADAMS, who recently resigned from the superintendency of the Federal Glass Company, Columbus, O., has completed some consulting work for the American Plate Glass Company at Kane, Pa., and expects to spend part of July at Ball Brothers Company, Muncie, Ind., and after that is planning to do some special consulting work for the Lancaster Glass Company, Lancaster, O., and the Imperial Glass Company, Bellaire, Ohio. Mr. Adams' address until September 1 will be 340 Spring street, Reading, Pa.

Recent Deaths

CHARLES B. MCLEAN, at one time president and general manager of the Allegheny Plate Glass Company, Glassmere, Pa., and also a prominent banker of Pittsburgh, died on June 12 at his home, 25 Gramercy Park, New York. Mr. McLean was 69 years of age and was born in Beaver County, Pa. He is survived by his widow, a daughter and a son.

JOHN J. POWER, an inventor of glassware making machines and for many years a patent attorney, died on June 4 at his home in Crofton, a suburb of Pittsburgh. Mr. Power was 53 years of age and was born in Manchester, England, coming to this country when he was about 18 years old. As a result of his inventions he became a large stockholder in several concerns using his patents, and through law suits undertaken in defense of his patents, he became a patent attorney. He is survived by his widow, four daughters and one son.

WILLIAM B. COGSWELL, managing director of the Solvay Process Company, Syracuse, N. Y., died on June 7th at his home in New York City. Mr. Cogswell was 87 years of age and was born in Oswego, N. Y. He was a graduate of the Rensselaer Polytechnic Institute at Troy, N. Y. During the Civil War, Mr. Cogswell was a mechanical engineer in the army and was superintendent of construction and operation of blast furnaces in Oneida County. He was interested in the first plant for making soda ash by the Solvay process erected in 1882 at Syracuse, N. Y.

Mr. Cogswell was a member of the American Institute of Mining Engineers, the American Society of Civil Engineers, American Society of Mechanical Engineers and several other organizations.

Monthly Summary of Foreign Commerce of the United States

Corrected to June 17, 1921.

IMPORTS OF GLASS AND GLASSWARE.

Articles	May 1920 Quantity	May 1920 Value	May 1921 Quantity	May 1921 Value	Eleven months ending May 1919 Quantity	Eleven months ending May 1919 Value	Eleven months ending May 1920 Quantity	Eleven months ending May 1920 Value	Eleven months ending May 1921 Quantity	Eleven months ending May 1921 Value
Glass and glassware:										
Bottles, vials, demijohns, carboys, and jars, plain, ordinarily used as containers, empty or filled ....lbs. dut.	232,691	$13,377	558,935	$20,932	1,834,770	$67,910	3,354,164	$157,638	7,624,177	$334,728
Bottles, decanters, and other glassware, cut or ornamented ....dut.	.....	51,023	.....	107,342	.....	237,641	.....	455,026	.....	1,462,251
Optical instruments, including lenses and spectacles ....dut.	.....	47,465	.....	135,383	.....	167,627	.....	452,944	.....	1,045,170
Sheet and plate glass—										
Cylinder, crown, and common window glass, unpolished ....lbs. dut.	865,165	83,235	5,917,958	291,543	567,007	54,079	2,514,004	270,419	22,950,657	1,526,567
Plate glass, cast, polished, unsilvered, sq. ft. dut.	74,318	48,075	191,373	148,799	273	210	335,482	241,562	3,291,999	2,912,594
Plates or disks, rough-cut or unwrought, for optical purposes ....lbs. free	53,993	100,102	68,097	68,134	628,915	345,134	617,670	573,378	1,014,431	963,043
All other ....dut.	.....	91,767	.....	179,203	.....	391,752	.....	815,022	.....	2,403,775
Total	.....	$435,044	.....	$951,336	.....	$1,264,353	.....	$2,965,989	.....	$10,648,128

EXPORTS OF GLASS AND GLASSWARE.

Glass and glassware:										
Bottles, demijohns, carboys, and jars	.....	$881,354	.....	$336,288	.....	$3,039,755	.....	$7,188,350	.....	$7,564,222
Chemical glassware	.....	19,125	.....	24,019	.....	182,594	.....	187,998	.....	278,553
Common window glass, boxes (50 sq. ft.).	44,287	$298,762	2,429	$27,817	780,720	$5,127,460	631,531	$4,128,056	335,515	$2,381,762
Exported to—										
France	4	55	.....	.....	137,189	1,092,749	4,570	35,756	7	61
Canada	18,411	115,941	94	450	159,254	819,908	303,343	1,743,417	141,932	920,163
Mexico	1,190	12,319	1,134	12,846	18,327	138,538	18,135	146,040	34,614	289,602
Cuba	4,597	34,326	945	12,598	28,030	191,306	29,989	206,445	31,869	252,264
Argentina	1,091	13,766	.....	.....	100,008	704,856	29,435	235,501	23,000	140,020
Brazil	2,129	16,133	.....	.....	46,139	291,988	45,835	336,492	17,362	120,067
Chile	2,163	14,455	.....	.....	60,035	418,701	25,250	159,119	7,928	51,773
Uruguay	392	2,866	.....	.....	.....	.....	7,600	54,061	13,556	87,616
China	3,768	19,534	.....	.....	.....	.....	34,120	251,751	5,135	38,429
Japan	502	4,265	.....	.....	5,317	68,960	21,003	185,466	10,411	85,157
Australia	676	5,182	.....	.....	121,927	717,882	16,089	112,553	6,955	48,829
New Zealand	390	2,777	.....	.....	23,806	130,069	4,730	30,873	944	9,100
Other countries	8,974	57,143	256	1,923	80,598	552,506	91,423	630,582	41,802	338,681
Cut or engraved glassware	.....	34,605	.....	10,742	.....	177,353	.....	313,964	.....	329,119
Plate glass, unsilvered ....sq. ft.	704,071	415,083	133,635	77,564	7,870,590	4,501,185	4,459,969	2,636,958	2,928,580	2,127,851
All other	.....	1,075,491	.....	522,032	.....	6,038,478	.....	9,081,009	.....	11,824,732
Total glass, etc.	.....	2,724,420	.....	998,462	.....	19,086,825	.....	23,536,335	.....	24,506,239

Current Prices of Glass-Making Materials

From quotations furnished by various manufacturers and dealers New York, July 2, 1921

	Carlots	Less Carlots
Alumina hydrate ....lb.	.06½	.07 – .07½
Arsenic trioxide (dense white, 99%) ....lb.	.07	.07½
Barium carbonate ....ton	65.00	75.00
Bone ash ....lb.	.05	.05½
Borax ....lb.	.05½	.06
Borax, fused, any mesh....lb.	.19	.20
Boric acid, fused ....lb.	.35	.35
Cadmium sulphide, red or orange ....lb.		1.60
Cadmium sulphide, yellow....lb.		1.80
Cobalt oxide ....bbls. lb.		3.00
Cobalt oxide ....tins, lb.		3.10–3.25
Copper oxide, red....lb.		.17– .20
Copper oxide, black....lb.	.23	.26
Feldspar, 100 mesh ....ton	18.00	
Fluorspar, powdered white, 90% ....ton	55.00	60.00
Kaolin ....ton	25.00	35.00
Kryolite ....lb.		.15
Lead oxide (red lead, Pb_3O_4) lb.	.08¾	.08¾
Litharge (PbO) ....lb.	.08¼	.08¼
Lime—		
Hydrated ....ton	45.00	
Burnt, ground, in bulk....ton	9.50	
Burnt, ground, in paper sacks ....ton	11.50	
Manganese (85% MnO_2) ....lb.	.04	.04½
Nickelic oxide (NiO) black...lb.		.35
Nickelous oxide (Ni_2O) green lb.		.38
Potassium carbonate—		
Calcined ....lb.	.07	
Hydrated ....lb.	.12	
Potassium nitrate ....lb.	.09½	.09¾
Powdered blue ....lb.		.30
Salt cake, for glassmakers..ton	20.00	.01½–.02 lb.

Current Prices—(Continued)

	Carlots	Less Carlots
Selenium ....lb.		2.25
Soda ash, 58% dense, 48% basis bulk ....100 lb.	1.65	1.70
Bulk, on contract....100 lb.	1.60	
Sodium nitrate ....lb.	.05¼	.05½
Sodium selenite ....lb.		2.25
Sulphur (flowers) ....lb.	.03	.03½
Sulphur (flour, heavy)....lb.	.02½	.03
Uranium oxide ....100 lb.		2.25
Zinc oxide (ZnO) ....lb.	.08½	.09

Stock Quotations

(Reported by Moore, Leonard & Lynch, Frick Building, Pittsburgh, Pa.)

Pittsburgh Stock Exchange—July 5th.

	Bid	Ask	Last
American Window Glass Machine com....	55	62	60
American Window Glass Machine pref....	70	72	72
American Window Glass pref....	93	95	95
Pittsburgh Plate Glass....	115	116	114
U. S. Glass....	30	35	35

Market dull but firm.

Wheeling Stock Exchange—July 5th.

	Bid	Ask	Last
Fostoria Glass Company....	100	108	108
Hazel Atlas Glass Company....	132	136½	136½
Imperial Glass Company....	88	100	100
Central Glass Company....	145	150	155

Market dull, with falling prices. There are many rumors current that the control of the Hazel Atlas Glass Company has passed to a large competitor.

Toledo Stock Exchange—July 5th.

	Bid	Ask	Last
Libbey-Owens Sheet Glass Company com..	81	87	85
Libbey-Owens Sheet Glass Company pref..	96	99	97
Owens Bottle Machine com....	29	30	29
Owens Bottle Machine pref....	No market		

Market dull. Prices lower.